

Nways Multiprotocol Access Services



# Software User's Guide

## Version 3.4



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**Note**

Before using this document, read the general information under "Notices" on page xxv.

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## Preface

This manual contains the information that you will need to use the router user interface for configuration and operation of the Multiprotocol Access Services base code installed on your Nways device. With the help of this manual, you should be able to perform the following processes and operations:

- Configure, monitor, and use the Multiprotocol Access Services base code.
- Configure, monitor, and use the interfaces and Link Layer software supported by your Nways device .

This manual is the first volume of the software library for the 2216, which is described in “Library Overview” on page xxx. A specific Nways device might not support all of the features and functions described within the library. If a feature or function is device-specific, that restriction is indicated in the relevant manual or is shown in a table in the preface of this manual.

This manual refers to the 2216 as either “the router” or “the device”. The examples in the library represent the configuration of a 2216, but the actual output you see may vary. Use the examples as a guideline to what you might see while configuring your device.

---

## Who Should Read This Manual

This manual is intended for persons who install and manage computer networks. Although experience with computer networking hardware and software is helpful, you do not need programming experience to use the protocol software.

---

## Getting Additional Information

Changes may be made to the documentation after the books are printed. If additional information is available or if changes are required after the books have been printed, the changes will be in a file (named README) on the CD-ROM. You can view the file with an ASCII text editor.

---

## About the Software

IBM Nways Multiprotocol Access Services is the software that supports the IBM 2216 (licensed program number 5765-C90). This software has these components:

- The base code, which consists of:
  - The code that provides the routing, bridging, data link switching, and SNMP agent functions for the device.
  - The router user interface, which allows you to configure, monitor, and use the Multiprotocol Access Services base code installed on the device. The router user interface is accessed locally through an ASCII terminal or emulator attached to the service port, or remotely through a Telnet session or modem-attached device.

The base code is installed at the factory on the 2216.

- The Configuration Program for IBM Nways Multiprotocol Access Services (referred to in this book as the *Configuration Program*) is a graphical user interface that enables you to configure the device from a stand-alone workstation. The Configuration Program includes error checking and online help information.

The Configuration Program is not pre-loaded at the factory; it is shipped separately from the device as part of the software order.

You can also obtain the Configuration Program for IBM Nways Multiprotocol Access Services from the IBM Networking Technical Support home page. See *Configuration Program User's Guide for Nways Multiprotocol and Access Services*, GC30-3830, for the server address and directories.

---

## Conventions Used in This Manual

The following conventions are used in this manual to show command syntax and program responses:

1. The abbreviated form of a command is underlined as shown in the following example:

```
reload
```

In this example, you can enter either the whole command (reload) or its abbreviation (rel).

2. Keyword choices for a parameter are enclosed in brackets and separated by the word or. For example:

```
command [keyword1 or keyword2]
```

Choose one of the keywords as a value for the parameter.

3. Three periods following an option mean that you enter additional data (for example, a variable) after the option. For example:

```
time host ...
```

In this example, you enter the IP address of the host in place of the periods, as explained in the description of the command.

4. In information displayed in response to a command, defaults for an option are enclosed in brackets immediately following the option. For example:

```
Media (UTP/STP) [UTP]
```

In this example, the media defaults to UTP unless you specify STP.

5. Keyboard key combinations are indicated in text in the following ways:
  - **Ctrl-P**
  - **Ctrl -**

The key combination **Ctrl -** indicates that you should press the Ctrl key and the hyphen simultaneously. In certain circumstances, this key combination changes the command line prompt.

6. Names of keyboard keys that you press are indicated like this: **Enter**
7. Variables (that is, names used to represent data that you define) are denoted by italics. For example:

```
File Name: filename.ext
```

---

## Library Overview

**Changes to the library structure:** Beginning with Version 3.2, the following changes to the organization of the library took place:

- The part titled **Understanding, Using and Configuring Features** has been moved into the *Using and Configuring Features* book from the *Nways Multiprotocol Access Services Software User's Guide*.



- The chapters on using, configuring, and monitoring the DIALs feature have been moved into the *Using and Configuring Features* book.

**Information updates and corrections:** To keep you informed of engineering changes, clarifications, and fixes that were implemented after the books were printed, refer to the IBM 2216 home pages at:

<http://www.networking.ibm.com/216/216prod.html>

The following list shows the books in the IBM 2216 library, arranged according to tasks.

## **Planning**

### **GA27-4105**

*IBM 2216 Introduction and Planning Guide*

This book is shipped with the IBM 2216. It explains how to prepare for installation and perform an initial configuration.

## **Installation**

### **GA27-4106**

*IBM 2216 Nways Multiaccess Connector Installation and Initial Configuration Guide*

This booklet is shipped with the IBM 2216. It explains how to install the IBM 2216 and verify its installation.

### **GX27-3988**

*2216 Nways Multiaccess Connector Hardware Configuration Quick Reference*

This reference card is used for entering and saving hardware configuration information used to determine the correct state of an IBM 2216.

## **Diagnostics and Maintenance**

### **SY27-0350**

*2216 Nways Multiaccess Connector Service and Maintenance Manual*

This book is shipped with the IBM 2216. It provides instructions for diagnosing problems with and repairing the IBM 2216.

## **Operations and Network Management**

The following list shows the books that support the Multiprotocol Access Services program.

### **SC30-3886**

*Software User's Guide*

This book explains how to:

- Configure, monitor, and use the Multiprotocol Access Services software.
- Use the Multiprotocol Access Services command-line router user interface to configure and monitor the network interfaces and link-layer protocols shipped with the IBM 2216.

### **SC30-3993**

*Using and Configuring Features*

### **SC30-3884**

*Protocol Configuration and Monitoring Reference Volume 1*

**SC30-3885***Protocol Configuration and Monitoring Reference Volume 2*

These books describe how to access and use the Multiprotocol Access Services command-line user interface to configure and monitor the routing protocol software shipped with the product.

They include information about each of the protocols that the devices support.

**SC30-3682***Event Logging System Messages Guide*

This book contains a listing of the error codes that can occur, along with descriptions and recommended actions to correct the errors.

**Configuration****GC30-3830***Configuration Program User's Guide for Nways Multiprotocol and Access Services*

This book discusses how to use the Configuration Program.

**Safety****SD21-0030***Caution: Safety Information—Read This First*

This book, shipped with the IBM 2216, provides translations of caution and danger notices applicable to the installation and maintenance of a IBM 2216.

**Marketing**

The following IBM Web page provides product information:

<http://www.networking.ibm.com/216/216prod.html>

---

## Summary of Changes for the IBM 2216 Software Library

The following list applies to the changes in the software that were made in Version 3 Release 4:

- Frame Relay enhancements:
  - New Frame Handler (FH) support
  - PU throttling to handle bursts of traffic in support of 3745 controllers
  - New interface type (Frame Relay subinterface) to allow virtual interfaces on the same physical interface
  - Unnumbered IP support
- VPN enhancements:
  - CPE enhancements:
    - Policy information from LDAP servers is locally stored.
    - Policy quick configuration.
    - Policy consistency checking.
    - Policy information may now be retrieved from LDAP servers within an administrative domain.
    - IPsec tunnel ping.
  - IP enhancements:
    - Voice routing enhancements:
      - IP Header Compression on PPP (RFCs 2507, 2508, 2509)

## Summary of Changes

- Interleaving voice traffic between fragmented data packets on multi-link PPP
- Interleaving voice traffic between fragmented data packets on Frame Relay
- Bypassing PPP or Frame Relay packet compression and encryption for voice traffic
- IP loopback address  
This support allows users to define IP addresses on a special interface to support TN3270 Gateway, Network Dispatcher, and IPSec requirements.
- IPv6
  - An inter-domain routing function (BGP4+) is provided for IPv6 that supports IPv6 routing and addressing information and uses TCP6 for transport.
  - IPv6 traffic is supported over ATM ethernet LAN emulation without encapsulation or tunneling.
- Multiple forwarding paths  
IP routing can use up to four equal-cost static routes to support multiple parallel links to a given address and mask.
- IP route aggregation
- Multicast enhancements:
  - Protocol Independent Multicast-Dense Mode (PIM-DM) for IPv4.
  - Network administrators can now control the flow of IP multicast data into and out of their networks by using inbound and outbound traffic filters.
- Not-so-stubby area (NSSA)  
OSPF supports not-so-stubby area (NSSA) as defined in RFC 1587 and the latest Internet draft is now supported.
- Random Early Detection (RED)
- Differential services policing enhancements
- VRRP enhancements:
  - The hardware MAC address may be used instead of a virtual MAC address to identify a redundant gateway; this can offer a performance improvement.
  - When more than one backup candidate is available, preempt options can be configured.
  - For selecting the master IP router, additional criteria, such as available route or network interface, can be used to support non-IP functions.
- Dial-on-demand alternate interface for WAN reroute
- TN3270 enhancements
  - LU capping
  - LU-pool load balancing
  - Talk 5 disconnect of TN3270 sessions
  - Additional reporting information
  - Support of addresses 1 and 255
- Network Dispatcher enhancements
  - Advertising of network dispatcher cluster addresses by routing protocols
  - A new SSL Advisor
- DLSw SDLC PU1 support
- Ethernet encapsulation support for both ethernet type II (default) and 802.3 simultaneously on the same interface
- DHCP enhancements:

## Summary of Changes

- Hardfile backup for lease information
- Multiple IP address support for DHCP interfaces
- Short lease support
- RADIUS enhancements
  - Radius scalability
  - Login of Last Resort
- L2TP Scalability
- Thin Server enhancement
  - Connection to an alternate or back-up master server
- Service file retrieval enhancements

### Clarifications and corrections

In hard copy and PDF, the technical changes and additions are indicated by a vertical line (|) to the left of the change.

---

## Network Utility

The Network Utility is a product that consists of various models of the 2216. It provides various subsets of the functions of the 2216, as shown in Table 1.

---

## Software Features Supported by Network Utility

Each model of Network Utility provides a subset of the software features of the 2216, as shown in Table 1. The 2216 Model 400 Web Server Cache (WSC) supports IP protocols and does not provide APPN features.

Table 1. Code Features supported in the 2216 Model 400 and Network Utility

Feature or Protocol	Available for 2216 Model 400 Base	Available for 2216 Model 400 WSC	Available for Network Utility Model TN1	Available for Network Utility Model TX1
TN3720E	Yes <sup>1</sup>	—	Yes <sup>1</sup>	—
TN3720E IBM eNetwork Host on-Demand Client Cache	Yes <sup>1</sup>	—	Yes <sup>1</sup>	—
TN3720E host-initiated dynamic LU definition	Yes <sup>1</sup>	—	Yes <sup>1</sup>	—
TN3720E multiple PUs SA over DLSw	Yes <sup>1</sup>	—	Yes <sup>1</sup>	—
Network Dispatcher	Yes	Yes	Yes	Yes
TN3720E Server Advisor (or Network Dispatcher Advisor)	Yes	Yes <sup>2</sup>	Yes	Yes <sup>2</sup>
Bandwidth reservation and priority queuing	Yes	Yes	Yes	Yes
Frame Relay packet fragmentation	Yes	Yes	Yes	Yes
Voice packet forwarding over Frame Relay	Yes	Yes	Yes	Yes
MAC filtering	Yes	Yes	Yes	Yes
WAN restoral	Yes	Yes	—	—
WAN reroute	Yes	Yes	—	—

## Summary of Changes

Table 1. Code Features supported in the 2216 Model 400 and Network Utility (continued)

Feature or Protocol	Available for 2216 Model 400 Base	Available for 2216 Model 400 WSC	Available for Network Utility Model TN1	Available for Network Utility Model TX1
Data compression	Yes	Yes	Yes	Yes
Encoding subsystem	Yes	Yes	Yes	Yes
Encryption	Yes	Yes	Yes	Yes
Data Link Switching (DLSw)	Yes	—	Yes	Yes
Quality of Service (QoS)	Yes	Yes	Yes	Yes
IPSec (IP Security)	Yes	Yes	Yes	Yes
Differentiated Services	Yes	Yes	Yes	Yes
L2TP	Yes	Yes	Yes	Yes
L2F	Yes	Yes	Yes	Yes
PPTP	Yes	Yes	—	—
Network Address Translation	Yes	Yes	Yes	Yes
AAA (Authentication, Authorization, and Accounting Security)	Yes	Yes	Yes	Yes
RSVP	Yes	Yes	Yes	Yes
DHCP services	Yes	Yes	Yes	Yes
Directory services: LDAP support	Yes	Yes	Yes	Yes
IPv6	Yes	—	Yes	Yes
Thin Server	Yes	—	—	—
Web Server Cache	—	Yes	—	—
SDLC primary group poll	Yes	—	Yes	Yes
SDLC two way simultaneous communication	Yes	—	Yes	Yes
IPX	Yes	—	—	—
Appletalk	Yes	—	—	—
DECnet IV	Yes	—	—	—
OSI	Yes	—	—	—
Banyan Vines	Yes	—	—	—
DIALs	Yes	Yes	Yes <sup>3</sup>	Yes <sup>3</sup>
<b>APPN features</b>				
Branch Extender	Yes	—	Yes	Yes
Dependent LU Requestor (DLuR)	Yes	—	Yes	Yes
Enterprise Extender	Yes	—	Yes	Yes
Extended Border Node	Yes	—	Yes	Yes
High-performance routing (HPR)	Yes	—	Yes	Yes

## Summary of Changes

Table 1. Code Features supported in the 2216 Model 400 and Network Utility (continued)

Feature or Protocol	Available for 2216 Model 400 Base	Available for 2216 Model 400 WSC	Available for Network Utility Model TN1	Available for Network Utility Model TX1
Network node (NN)	Yes	—	Yes	Yes
<ol style="list-style-type: none"><li>1. This is a separately priced feature</li><li>2. When communicating with a TN3270E server on an IBM routing product</li><li>3. Accessible only by using tunneling. Tunneling functions include L2TP, PPTP, and L2F.</li></ol>				

---

# Part 1. Understanding and Using the Software





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## Chapter 1. Getting Started

This chapter shows you how to get started with using the following components related to the IBM 2216 Model 400 Switch (2216) and the Multiprotocol Access Services:

- Device console terminals
- Device software (Multiprotocol Access Services)
- Device software user interface

The information in this chapter is divided into the following sections:

- “Before You Begin”
- “Accessing the Software Using Local and Remote Consoles”
- “Discussing the User Interface System” on page 6

---

### Before You Begin

Before you begin, refer to the following checklist to verify that your device is installed correctly.

Have you...

- Installed all necessary hardware?
- Connected the console terminal (video terminal) to the device?

**Attention:** If you are using a service port-attached terminal to configure or monitor your IBM 2216 and your service terminal is unreadable, you need to change some parameters in your configuration.

Refer to your hardware documentation.

- Connected your device to the network using the correct network interfaces and cables?
- Run all necessary hardware diagnostics?

For more information on any of these procedures, refer to the *IBM 2216 Nways Multiaccess Connector Installation and Initial Configuration Guide*.

### Migrating to the Current Release

Refer to the *2216 Nways Multiaccess Connector Service and Maintenance Manual* for information about migrating to a new code level.

---

### Accessing the Software Using Local and Remote Consoles

The device console lets you use the device user interface to monitor and change the function of the device's networking software. The device supports local and remote consoles.

#### Local Consoles

Local consoles are either directly connected by an EIA 232 (RS-232) cable, or connected via modems to the device. You may need to use a local console during the initial software installation. After the initial setup connection, you can connect using Telnet, as long as IP forwarding has been enabled. (Refer to *Protocol Configuration and Monitoring Reference* for more information on enabling IP forwarding.)

When the configured device is started for the first time, a boot message appears on the screen, followed by the OPERator's CONsole or OPCON prompt (\*). The \* prompt indicates that the device is ready to accept OPCON commands.

You will need to use an ASCII terminal attached to the 2216 service port to initially configure it.

**Important:** Garbage, random characters, reverse question marks, or the inability to connect your terminal to the 2216 service port can have many causes. The following list contains some of those causes:

- The most common cause of garbage or random characters on the service console is that the baud rate is not synchronized with the IBM 2216.

If the 2216 is set to a specific baud rate, the terminal or terminal emulator must be set to the same baud rate.

If the IBM 2216 is set to autobaud (this is the default), press the terminal break key sequence and press **Enter**.

A typical break key sequence for PC terminal emulators is Alt-B (refer to the terminal emulator documentation). Most ASCII terminals have a **Break** key (often used in conjunction with the **Ctrl** key).

Refer to your hardware documentation for more information.

- Defective terminal or device (ac) grounds.
- Defective, incorrectly shielded, or incorrectly grounded EIA 232 (RS-232) cable between the terminal and the IBM 2216.
- Defective terminal or terminal emulator.
- Defective IBM 2216 system board.
- High ambient electromagnetic interference (EMI) levels.
- Power line disturbances.

Once the 2216 is initially configured, you will not need a local console for device operation, as long as IP is enabled.

The device software automatically handles console activity. When upgrading the software, you might have to use the local console. For information on attaching and configuring local consoles, refer to the *IBM 2216 Nways Multiaccess Connector Installation and Initial Configuration Guide*.

## Remote Consoles

Remote consoles attach to the device using a standard remote terminal protocol. Remote consoles provide the same function as local consoles, except that a local console must be used for initial configuration. You can use no more than two remote consoles at the same time on a device. You can connect remote consoles to the device through a Telnet connection. You have the option to disable this feature.

### Telnet Connections

The device supports both Telnet Client and Server. The remote console on the device acts as a Telnet server. The device acts as a Telnet client when connecting from the device to either another device or a host using the **telnet** command in the OPCON (\*) process.

## Remote Login Names and Passwords

During a remote login, the device prompts you for a login name and password. You can display the login name when logged in to the device from a remote console by using a device **status** command.

## Logging in Remotely or Locally

Logging in to a local console is the same as logging in to a remote console except that you must connect to the device by starting Telnet on your host system. To log in remotely, begin at step 1. To log in locally, begin at step 3.

To log in from a remote console:

1. Connect to the device by starting Telnet on your host system. Your host system is the system to which remote terminals are connected.

2. Supply the device's name or Internet Protocol (IP) address.

To use device names, your network must have a name server. Issue either the device name or the IP address as shown in the following example:

```
% telnet brandenburg
```

*or*

```
% telnet 128.185.132.43
```

At this point, it makes no difference whether you have logged in remotely or locally.

3. If you are prompted, enter your login name and password.

```
login:  
Password:
```

It is possible that there is a login and no password. The password controls access to the device. If a password has not been set, press the **Enter** key at the Password: prompt. Logins are not set automatically. For security, you can set up user names and passwords using the **add user** command in the CONFIG process. For additional information, see the description of the **add user** command on 78. Remember to reload to activate any changes.

**Note:** If you do not enter a login name and valid password within 1 minute of the initial prompt, or if you enter an incorrect password three times in succession, the device drops the Telnet connection.

4. Press the **Enter** key to display the asterisk (\*) prompt.

You may have to press the **Enter** key more than once or press **Ctrl-P** to obtain the \* prompt.

Once at this level, you can begin to enter commands from the keyboard. Press the **Backspace** key to delete the last character typed in on the command line. Press the **Delete** key or **Ctrl-U** to delete the whole command line entry so that you can reenter a command. See "Command Completion" on page 22 and "Command History" on page 25 for more information.

You can also use local Telnet commands on your Telnet client to close the Telnet connection.

**Note:** If you use a VT100 terminal, do not press the **Backspace** key, because it inserts invisible characters. Use the **Delete** key.

5. Exit the device as described in "Exiting the Device" on page 6.

## Reloading the Device

Use the **reload** command to reboot the device by loading a new copy of the configuration from memory. Whenever you change a user-configurable parameter that is not dynamically configurable, you must reload the device for the change to take effect. For example:

```
* reload
```

```
The configuration has been changed, save it? (Yes or [No] or Abort)
```

```
Are you sure you want to reload the gateway? (Yes or [No]): yes
```

## Exiting the Device

Return to the \* prompt and use the **logout** command to close the Telnet connection. For example:

```
IP Config> exit  
Config> Ctrl-P  
* logout  
  
%
```

You can also use local Telnet commands on your Telnet client to close the Telnet connection.

---

## Discussing the User Interface System

The software is a multitasking system that schedules use of the CPU among various processes and hardware devices. The device software:

- Provides timing and memory management, and supports both local and remote operator consoles from which you can view and modify the device's operational parameters.
- Consists of functional modules that include various user interface processes, all network interface drivers, and all protocol forwarders purchased with the device.

## Understanding the First-Level User Interface

The user interface to the software consists of the main menu (process) and several subsidiary menus (processes). These menus are related to the multiple levels of processes in the software.

The first level of processes consists of the OPCODE and CONFIG-ONLY processes. In most cases, you will use the OPCODE process to access the second level to configure or operate the base services, features, interfaces, and protocols you will run on your IBM 2216.

The second level contains processes such as Configuration (CONFIG), Console (GWCON) and Event Logging System (MONITR). You may use the OPCODE commands **configuration**, **console** or **event** to access these second level processes. Alternatively, you may use the **status** command to list the second level processes and then use the **talk pid** command to access the second-level processes. There are processes that you cannot use in the software. See Table 2 on page 10 for an overview of the processes.

Figure 1 on page 7 shows the processes and how they fit within the structure of the device software.

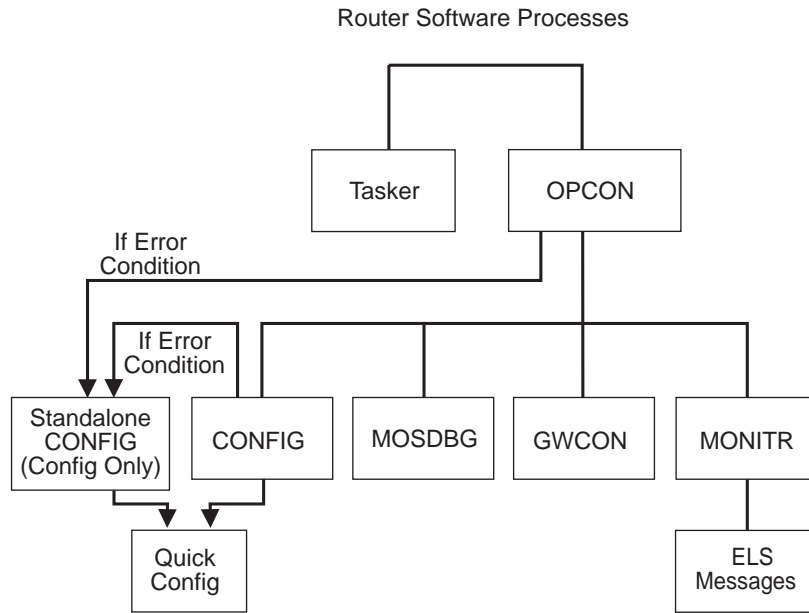


Figure 1. Multiprotocol Access Services

Figure 2 is an example of the relationship between the various process levels.

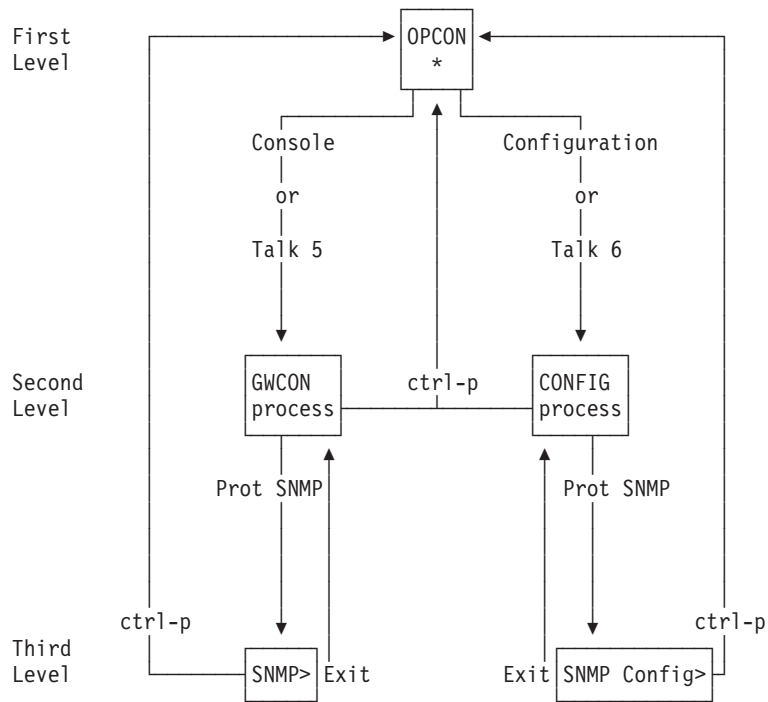


Figure 2. Relationship of Processes and Commands

**Note:** Also shown in Figure 2 are the various commands to access each process level and return from each process level.

See “What is the OPCON Process?” on page 31 for more information about OPCON, and “Config-Only Mode” on page 63 for more information about CONFIG-ONLY.

The ROPCON process handles processing from remote consoles and is essentially the same as the OPCON process.

### **Quick Configuration Process**

Quick Configuration, or Quick Config, allows you to quickly configure portions of the device without dealing with the specific operating system commands. When you initially load, restart, or reload the device with no configuration, you enter Config-Only and you can access Quick Config menus from that process. If the device has devices configured and the devices do not have any protocols configured, the device automatically starts Config-Only and then enters Quick Config.

You can also enter Quick Config from the CONFIG process using the **qconfig** command.

### **System Security**

Multiple users with login permissions can be added using the **add user** command. See “Configuring User Access” on page 66 for details on security issues and for information on the **set password** and **add user** commands.

---

## Chapter 2. Using the Software

This chapter describes how to use the software. It consists of:

- “Entering Commands”
- “Connecting to a Process”
- “Some Configuration Suggestions” on page 11
- “Accessing the Second-Level Processes” on page 13
- “Accessing the Third-Level Processes” on page 15
- “Command Completion” on page 22
- “Command History” on page 25

---

### Entering Commands

When typing a command, remember the following:

- You may type only enough sequential letters of the command to make it unique among the available commands. For example, to execute the **reload** command you must enter **rel** as a minimum. The minimum number of required characters are underlined in the command syntax chapters.
- Commands are not case-sensitive.
- Sometimes, only the first letter of the command (and subsequent options) is required to execute the command. For example, typing **s** at the \* prompt followed by pressing the **Enter** key causes the **status** command to be executed.
- When command completion is enabled, you can press Esc and enter **?** to obtain help on entering commands. See “Command Completion” on page 22 and “Command History” on page 25 for more information.

---

### Connecting to a Process

When you start the device, the console displays a boot message. The OPCON prompt (\*) then appears on the screen indicating that you are in the OPCON process and you can begin entering OPCON commands. This is the command prompt from which you communicate with different processes.

Commands that are needed more often appear before the “- - - -” separator. Enter the appropriate command at the OPCON prompt (\*). See Table 4 on page 31 for a list of commands.

Alternatively, you can:

1. Find out the process ID (PID) number of a process by entering the **status** command at the \* prompt.

The **status** command displays information about the device processes, such as the process IDs (PIDs), process names and status of the process. Issuing the **status** command is shown in the following example:

```
* status
Pid  Name   Status TTY  Comments
1    COpCn1 RDY   TTY0
2    Monitr DET   --
3    Tasker RDY   --
4    MOSDBG DET   --
5    CGWCon DET   --
6    Config DET   --
7    ELScon DET   --
8    ROpCn1 IDL   TTY1 128.185.210.125
9    ROpCn2 IDL   TTY2
```

- Use the **talk pid** command, where *pid* is the number of the process to which you want to connect. (For more information about these and other OPCON commands, refer to “What is the OPCON Process?” on page 31.)

**Note:** Not every process listed has a user interface (for example, the **talk 3** process). The **talk 4** command is for use by your service representatives.

## Identifying Prompts

Each process uses a different prompt. You can tell which process your console is connected to by looking at the prompt. (If the prompt does not appear when you enter the **talk pid** command, press **Enter** again.)

The following list shows the prompts for the five main processes:

*Table 2. Processes, Their Purpose, and Commands to Access*

Process	Level and Purpose	Command to Access	Input Prompt
OPCON	Level 1 - access to all secondary levels	<b>Ctrl-P</b>	asterisk (*)
CONFIG	Level 2 - base services configuration and access to configuration third level	<b>Configuration or talk 6</b>	Config >
GWCON	Level 2 - base services operation and monitoring and access to operations and monitoring on third level	<b>Console or talk 5</b>	plus sign (+)
MONITR	Level 2 - message display	<b>Event or talk 2</b>	(none)
ELSScon	Level 2 - direct monitoring and access to ELS console	<b>els or talk 7</b>	ELS Secondary Console>
MOSDBG	Level 2 - diagnostic environment	<b>talk 4</b>	db>
DIAGS	Level 2 - run hardware diagnostics	<b>diags</b>	
<b>Note:</b> Only enter the <b>talk 4</b> command under the direction of a service representative.			

At the OPCON prompt level, you can begin to enter commands from the keyboard. Use the **Backspace** key to delete the last character typed in on the command line. Use **Ctrl-U** to delete the whole command line entry so that you can reenter a command. See “Command Completion” on page 22 and “Command History” on page 25 for additional details or press **Escape ?**.

## Getting Help

At the command prompts, you can obtain help in the form of a listing of the commands available at that level. To do this, type **?** (the **help** command), and then press **Enter**. Use **?** to list the commands that are available from the current level. You can usually enter a **?** after a specific command name to list its options.

## Exiting a Lower Level Environment

The multiple-level nature of the software places you in secondary, tertiary, and even lower level environments as you configure or operate the 2216. To return to the next higher level, enter the **exit** command. To get to the secondary level, continue entering **exit** until you receive the secondary level prompt (either Config> or +).

For example, to exit the ASRT protocol configuration process:



```
ASRT config> exit
Config>
```

If you need to get to the primary level (OPCON), enter the intercept character (**Ctrl-P** by default).

## Getting Back to OPCON

To get back to the OPCON prompt (\*), press **Ctrl-P**. You must always return to OPCON before you can communicate with another process. For example, if you are connected to the console (GWCON) process and you want to connect to the CONFIG process, you must press **Ctrl-P** to return to OPCON first. The **Ctrl-P** key combination is the default *intercept character*.

If you use the intercept character from a third-level or lower level menu to return to the \* prompt, the next time you use the **talk** command to talk to the same process, you will reenter that same level menu. This link goes away when the device is re-initialized.

---

## Some Configuration Suggestions

Configuring a 2216 is different depending on whether you are configuring for the first time, creating a configuration based on an existing configuration, or just updating a configuration. Use the following sections as a guide to the best procedure to use, depending on your needs.

## Creating a First Configuration

This procedure assumes that you have no other 2216 that contains a configuration similar to the one for the 2216 you are configuring. The procedure also assumes that you have just taken the 2216 out of the box. Although this procedure specifies an order, you can perform the actual configuration (after step 3) in any order.

To configure a IBM 2216 for the first time:

1. Examine the 2216 you are configuring to determine which interfaces you need to configure. Note these for later use.
2. Connect to the 2216 as described in “Accessing the Software Using Local and Remote Consoles” on page 3.
3. Initially configure a port on the 2216 and at least an internal IP address for the device using Quick Config as described in “Quick Configuration” on page 65 or “Appendix A. Quick Configuration Reference” on page 755. Configure the minimum needed to allow you to Telnet into the device.
4. Configure any base services, such as boot options. Access the configuration process as described in “Accessing the Configuration Process, CONFIG (Talk 6)” on page 13.
5. Configure the interfaces. Access the interface configuration process as described in “Accessing the Network Interface Configuration Process” on page 15.
6. Configure any required features. Access the feature configuration process as described in “Accessing Feature Configuration and Operating Processes” on page 20.
7. Configure any protocols that will run through this device. Access the protocol configuration process as described in “Accessing Protocol Configuration and Operating Processes” on page 21.

**Note:** At the very least, you will configure IP in this step.

8. Reload the device as described in “Reloading the Device” on page 6.

## Basing a Configuration on an Existing Configuration

This section describes how to:

- Base a configuration on the configuration in an operating 2216
- Permanently update the configuration in a 2216
- Temporarily update the configuration of a 2216 while the 2216 is operating

### Basing on an Existing Configuration

If you already have a 2216 that has the same interfaces, features, and protocols that you want to configure on a new 2216, you can save time by basing the configuration on the existing 2216. You can perform this type of configuration either using the command line interface or by using the configuration program that comes with the 2216. In both cases, the procedures assume that the 2216 is not in your production network.

To base a configuration on an existing configuration using the command line interface:

1. Obtain a copy of the configuration you want to use.
  - a. Enter **talk 6** at the OPCON (\*) prompt.
  - b. Enter **boot** at the Config> prompt.
  - c. Enter the **copy configuration file** command at the Boot config> prompt. See “Chapter 5. Using BOOT Config to Perform Change Management” on page 45 for more information.
2. Connect to the 2216 that you are configuring.
3. Load the configuration you obtained in step 1 into the 2216 using TFTP GET. See “Chapter 5. Using BOOT Config to Perform Change Management” on page 45.
4. Update the configuration.
5. Write the configuration. See “What is CONFIG?” on page 63.
6. Reload the 2216.

To base a configuration on an existing configuration using the configuration program:

1. Start the configuration program.
2. Retrieve the configuration from the 2216 on which you want to base the new configuration.
3. Make the changes you need for the new configuration. These changes include addresses, the host names, users, and other items.
4. Save the configuration with a different name from the name that you used to retrieve the configuration.
5. Send the configuration to the 2216 you are configuring.
6. Reload the 2216.

For details about using the configuration program, see *Configuration Program User's Guide for Nways Multiprotocol and Access Services*.

### Permanently Updating a Configuration

To permanently update a configuration:

1. Access the 2216 you are updating as described in “Accessing the Software Using Local and Remote Consoles” on page 3. You will see the \* prompt.

2. Enter the **talk 6** command to access the configuration process.
3. Enter the appropriate commands to access the third-level process that configures the areas that you are changing.
4. Enter **exit** as many times as needed to return to the configuration process.
5. Write the configuration. See “What is CONFIG?” on page 63.
6. Reload the 2216.

### Temporarily Updating a Configuration

The ability to temporarily update a configuration allows you to make changes to some of the operating characteristics of a 2216 until you can make permanent updates to the configuration. This enables you to implement changes immediately to resolve problems or improve performance and avoid an outage during a peak period. You can then make permanent updates to the configuration and schedule an outage so you can reload to pick up the change.

To temporarily update a configuration:

1. Access the 2216 you are updating as described in “Accessing the Software Using Local and Remote Consoles” on page 3. You will see the \* prompt.
2. Enter the **talk 5** command to access the operating/monitoring process.

**Note:** Not all interface types, protocols, or features allow you to make temporary config changes via talk 5 commands.

3. Enter the appropriate commands to access the third-level process that monitors the areas that you are changing.
4. Enter **exit** as many times as needed to return to the operating/monitoring process.
5. Enter **Ctrl-P** to return to the \* prompt.
6. Exit the device as described in “Exiting the Device” on page 6

---

## Accessing the Second-Level Processes

All interfaces, features, and protocols have commands that you use to access the following processes:

- The configuration process to initially configure and enable the interface, feature, or protocol, as well as perform later configuration changes.
- The operating/monitoring process to display information about each interface, feature, or protocol, to make temporary configuration changes, or to activate configuration changes.

You can also configure or operate some base system services through the second-level processes. The commands to perform these functions are described starting in “What is CONFIG?” on page 63.

The next sections describe the procedures for accessing the second-level processes.

### Accessing the Configuration Process, CONFIG (Talk 6)

Each protocol configuration process is accessed through the device’s CONFIG process. CONFIG is the second-level process of the device user interface that lets you communicate with third-level processes. Protocol processes are examples of third-level processes.

The CONFIG command interface is made up of levels of menus. Protocol configuration command interfaces are menus within the CONFIG interface. Each protocol configuration interface has its own prompt. For example, the prompt for the SNMP protocol command interface is `SNMP config>`.

The next sections describe these procedures in more detail.

### Entering the CONFIG Process

To enter the CONFIG process from OPCON and obtain the CONFIG prompt, enter the **configuration** command. Alternatively, you can enter the OPCON **talk** command and the PID for CONFIG. The PID for CONFIG is 6.

```
* configuration
```

or

```
* talk 6
```

The console displays the CONFIG prompt (`Config>`). If the prompt does not appear, press the **Enter** key again.

**Quick Configuration Process:** Quick Configuration, or Quick Config, allows you to quickly configure portions of the device without dealing with the specific operating system commands. You enter the Quick Config menus from the CONFIG process using the **qconfig** command (see “Quick Configuration” on page 65).

### Reloading the Device

Changes that you make to the protocol parameters through CONFIG do not take effect until you either activate the net that contains any dynamic changes or reload the device software.

**Note:** You must enter the **write** command to save the changes in the device’s flash memory.

To reload the device, enter the OPCON **reload** command. For example:

```
* reload
```

```
Are you sure you want to reload the gateway? (Yes or No): yes
```

## Accessing the Console Operating/Monitoring Process, GWCON (Talk 5)

To view information about the interfaces, features, or protocols or to change parameters while running, you must access and use the operating (monitoring) process. Operating command interfaces are modes of the GWCON interface. Within the GWCON mode, each interface, feature, or protocol interface has its own prompt. For example, the prompt for the SNMP protocol is `SNMP>`.

**Note:** Any parameters you change in this process will not remain active across any event that causes the 2216 to reload the operational code, such as a power outage or entering the **reload** command.

The next sections describe these procedures in more detail.

### Entering the GWCON Command Process

To enter the GWCON process from OPCON and obtain the GWCON prompt, enter the **console** command. Alternatively, you may enter the **talk** command and the PID for GWCON. The PID for GWCON is 5. For example:

```
* console
```

or

\* talk 5

The GWCON prompt (+) then displays on the console. If the prompt does not appear, press **Enter** again.

## Accessing the Secondary ELS Console Process, ELSScon (Talk 7)

The Secondary ELS Console provides convenient access to GWCON talk 5 ELS without disrupting the current state of GWCON. You may be in the middle of a **ping** in talk 5, or deep inside a talk 5 menu structure, and want to control ELS without disrupting the current state of GWCON. The secondary ELS console (Talk 7) serves this purpose.

To enter the Secondary ELS Console (ELSScon) process from OPCON and obtain the Secondary ELS Console prompt, enter the **els** command. Alternatively, you may enter the **talk 7** command.

In the following example, another ELS event is displayed while performing a **ping** command.

**Note:** The intercept character (Ctrl-P by default) is used to obtain the OPCON prompt (\*).

```
*talk 5
+protocol ip
IP>ping 10.0.0.9
PING 10.0.0.2 -> 10.0.0.9: 56 data bytes, ttl=64, every 1 sec.

*talk 7

ELS Secondary Console>display event ip.7
Complete
ELS Secondary Console>
*talk 2
00:20:48 IP.007: 10.0.0.2 -> 10.0.0.9
00:20:49 IP.007: 10.0.0.2 -> 10.0.0.9
```

---

## Accessing the Third-Level Processes

After accessing the second level, you must enter commands on the third level to configure or operate the interfaces, features, and protocols in your IBM 2216. The following sections describe how to access the third level processes.

### Adding Devices

This section describes how to use the **add device** command to configure the network interfaces. A network interface is usually an adapter, but it can also be a definition used by an operating process. For example, two IP addresses can be assigned to one port and each one is considered an interface. After you establish an interface using the **add device** command, you can access the network interface configuration and operating processes, for example, the Talk 5 monitoring processes. These processes are used to change and monitor the software-configurable parameters for the network interfaces that are used in your device.

### Accessing the Network Interface Configuration Process

Use the following procedure to access the device's configuration process. This process gives you access to a specific interface's *configuration* process.

1. At the OPCON prompt, enter the **configuration** command.

```
* configuration
```

After you enter the **configuration** command, the CONFIG prompt (Config>) displays on the console. If the prompt does not appear when you first enter **configuration**, press **Enter** again.

Use the **add device** command to create a network interface. The **add device** command automatically assigns the interface number. (Enter **add device ?** to get a list of the supported device types.)

These are the types of devices that are supported:

a. Multi-port adapters

When you specify a multi-port adapter device name with the **add device** command, you are prompted for the adapter's slot number and the port number on the adapter that you want to use for the interface.

If you want to use multiple ports on an adapter, you must enter the **add device** command multiple times and specify a different port number each time.

For example, you would enter the following commands to create interfaces for ports 0 and 1 on the 8-port X.21 adapter in slot 7.

```
Config> add device x21
Device Slot #(1-8) [1]? 7
Device Port #(0-7) [0]? 0
Defaulting Data-link protocol to PPP
Adding X.21 PPP device in slot 7 port 0 as interface #6
Use "set data-link" command to change the data-link protocol
Use "net 6" to configure X.21 PPP parameters

Config> add device x21
Device Slot #(1-8) [1]? 7
Device Port #(0-7) [0]? 1
Defaulting Data-Link protocol to PPP
Adding X.21 PPP device in slot 7 port 1 as interface #7
Use "set data-link" command to change the data-link protocol
Use "net 7" to configure X.21 PPP parameters
```

**Note:** The serial adapter port numbers are 0-based. The port numbers for all other multi-port adapters are 1-based.

The 4-port ISDN Channelized T1 and E1 adapters allow you to configure multiple ports with one **add device** command. When you add one of these adapters, the software will prompt you for a range of ports to add. The following example shows how you would add a 4-port ISDN Channelized T1 and E1 adapter into slot 4 that is using dial-in nets:

```
Device Slot #(1-8) [1]? 3
Device Port Range (1-8)
  Lowest Port #(1) [1]? 2
  Highest Port #(8) [8]? 2
Automatically add dial-in nets for this base net? (Yes or [No]): yes
Automatically enable IP for these dial-in nets?(Yes or [No]): yes
Enable as a Multilink PPP link?(Yes or [No]): yes
Adding 23 dial-in nets on top of base net 14
Adding 8-port ISDN Primary T1/J1 devices in slot 3 port 2 as interfaces #14.
Use "net 14" to configure 8-port ISDN Primary T1/J1 parameters.
```

b. Single-port adapters

When you specify a single-port adapter device name with the **add device** command, you are prompted for the adapter's slot number.

The following example adds an interface for the 1-port ISDN-PRI T1/J1 adapter in slot 2:

```
Config> add device t1-isdn
Device Slot #(1-8) [1]? 2
Adding ISDN Primary T1/J1 device in slot 2 port 1 as interface #7
Use "net 7" to configure ISDN Primary T1/J1 parameters
```

c. Dial circuits

The following example adds a dial circuit interface:

```

Config> add device dial-circuit
Enter the number of PPP Dial Circuit interfaces [1]?
Adding device as interface 8
Base net for this circuit[0]?4
Defaulting Data-link protocol to PPP
Use "set data-link" command to change the data-link protocol
Use "net 8" command to configure circuit parameters

```

d. The following example adds a dial-in circuit:

```

Config>add device dial-in
Enter the number of dial-in interfaces [1]?
Adding device as interface 5
Base net for this circuit [0]? 5
Defaulting Data-link protocol to PPP
Use "set data-link" command to change the data-link protocol
Use "net 5" command to configure circuit parameters

```

e. Multilink PPP

The following example adds a multilink PPP interface:

```

Config>add device multilink-ppp
Enter the number of Multilink PPP interfaces [1]?
Adding device as interface 7
Defaulting Data-link protocol to PPP
Use "net 7" command to configure circuit parameters

```

### Notes:

- a. When you create interfaces for serial adapters or dial circuits, the default data-link type is PPP. However, you can use the **set data-link** command to change the data-link type. Refer to Table 3 on page 18 for the data-link types supported on serial ports and dial circuits, and to the description of the **set data-link** command on page 100.
2. At the Config> prompt, enter the **list devices** command to display the network interface numbers for which the device is currently configured, as follows:

```

Config> list devices

Ifc 0 Token Ring           Slot: 1 Port: 1
Ifc 1 Token Ring           Slot: 1 Port: 2
Ifc 2 Token Ring           Slot: 2 Port: 1
Ifc 3 Token Ring           Slot: 2 Port: 2
Ifc 4 Ethernet             Slot: 4 Port: 1
Ifc 5 Ethernet             Slot: 4 Port: 2
Ifc 6 Ethernet             Slot: 5 Port: 1
Ifc 7 Ethernet             Slot: 5 Port: 2
Ifc 8 Ethernet             Slot: 6 Port: 1
Ifc 9 Ethernet             Slot: 6 Port: 2
Ifc 10 V.35/V.36 Frame Relay Slot: 8 Port: 0
Ifc 11 V.35/V.36 X.25      Slot: 8 Port: 1
Ifc 12 V.35/V.36 PPP       Slot: 8 Port: 2
Ifc 13 V.35/V.36 PPP       Slot: 8 Port: 3
Ifc 14 V.35/V.36 PPP       Slot: 8 Port: 4
Ifc 15 V.35/V.36 PPP       Slot: 8 Port: 5

```

3. Record the interface numbers.
4. Enter the CONFIG **network** command and the number of the interface you want to configure. For example:

```
Config> network 1
```

The appropriate configuration prompt (such as TKR Config> for token-ring), now displays on the console.

**Note:** Not all network interfaces are user-configurable. For interfaces that cannot be configured, you receive the message:

```
That network is not configurable
```

**IBM 2216 Device Support Restrictions:** The following rules apply when adding devices to the IBM 2216:

- As many as two ATM interfaces may be defined.



- As many as eight ISDN-PRI interfaces may be defined with the following restrictions:
  - No more than four 1-port adapters may be used
  - No more than one 4-port ISDN Channelized T1 and E1 adapter may be used
- Adding a LAN device in slot 3, 4, 7, or 8 will disable the other slot in the pair. For example, if you add a LAN device to slot 4, slot 3 will be disabled. Likewise, if you add the device to slot 3, slot 4 will be disabled. The same rules apply for adding a LAN device in slots 7 and 8.
- All interfaces on a V.35/V.36 adapter must use either V.35 cables or V.36 cables. The type of fan out cable attached to the V.35/V.36 adapter determines which type of cables (V.35 or V.36) can be used.

**Displaying the Interface Configuration:** From the same interface configuration prompts, you can list configuration information specific to that selected interface by using the **list** command. For example:

```
TKR Config> list
Token-Ring configuration:
PACKET SIZE (INFO FIELD): 4472
Speed:                    16 Mb/sec
Media:                   Shielded
RIF Aging Timer:         120      Source Routing:      Enabled
MAC Address:             000000000000
```

**Configuring the Network Interface:** Refer to the specific chapters in this guide for complete information on configuring your IBM 2216's network interfaces.

Table 3 lists network architectures and the supported interfaces for each architecture.

*Table 3. Network Architecture and the Supported Interfaces*

Network Architecture	Supported Interfaces
ATM	1-Port ATM 155-Mbps MMF 1-Port ATM 155-Mbps SMF
802.5 Token-Ring	2-Port Token-Ring
Ethernet	<ul style="list-style-type: none"> <li>• 1-port 10/100-Mbps Ethernet</li> <li>• 2-Port 10-Mbps Ethernet</li> </ul>
ISDN	<ul style="list-style-type: none"> <li>• 1-Port ISDN-PRI (T1/J1) *</li> <li>• 1-Port ISDN-PRI (E1) *</li> <li>• 4-port ISDN Channelized T1 and E1 *</li> </ul> <p><b>Note:</b> The interfaces marked with an asterisk (*) can be used either as ISDN or channelized interfaces.</p>
Point-to-Point	8-port V.24/EIA 232E, 6-port V.35/V.36, 8-port X.21, 1-port HSSI, and dial circuit interfaces
Frame Relay	8-port V.24/EIA 232E, 6-port V.35/V.36, 8-port X.21, 1-port HSSI, and dial circuit interfaces
X.25	8-port V.24/EIA 232E, 6-port V.35/V.36, and 8-port X.21 adapters
SDLC Relay	8-port V.24/EIA 232E, 6-port V.35/V.36, and 8-port X.21
SDLC	8-port V.24/EIA 232E, 6-port V.35/V.36, 8-port X.21, and dial circuit interfaces
V.25 bis	8-port V.24/EIA 232E



Table 3. Network Architecture and the Supported Interfaces (continued)

Network Architecture	Supported Interfaces
Dial-In	A PPP dial circuit interface that has configuration parameters defaulted to support DIALs
Multilink PPP (MP)	Supported on any PPP link
ESCON Channel Adapter	LAN Channel Station (LCS), Link Services Architecture (LSA), and Multi-Path Channel+ (MPC+)
Parallel Channel Adapter	LAN Channel Station (LCS), Link Services Architecture (LSA), and Multi-Path Channel+ (MPC+)
L2TP, L2F, and PPTP	Supports virtual PPP DIALs connections through the Layer 2 Tunneling Protocol (L2TP), Layer 2 Forwarding (L2F), and Point to Point Tunneling Protocol (PPTP).
FDDI	1-port FDDI

**Notes:**

1. PPP dial circuit interfaces can use ISDN or V.25 bis as the base network interface.
2. FR dial circuit interfaces can use an ISDN or a V.25 bis network as the base network interface.
3. Dial-In circuit interfaces can use an ISDN network as the base network interface.
4. SDLC dial circuits use V.25 bis as the base network interface.

**Accessing the Network Interface Console Process**

To monitor information related to a specific device, access the console process by using the following procedure:

1. At the OPCON prompt, enter the **console** command. For example:  
\* console
2. The GWCON prompt (+) is displayed on the console. If the prompt does not appear when you first enter GWCON, press **Enter** again.
3. At the GWCON prompt, enter the **configuration** command. For example:

+configuration

Multiprotocol Access Services

2216-MAS Feature 2822 V3.2 Mod 0 PTF 0 RPQ 0 MAS.EF9 cc4\_2a

```

Num Name Protocol
0 IP DOD-IP
3 ARP Address Resolution
4 DN DNA Phase IV
6 VIN Banyan Vines
7 IPX NetWare IPX
10 BGP Border Gateway Protocol
11 SNMP Simple Network Management Protocol
12 OSPF Open SPF-Based Routing Protocol
22 AP2 AppleTalk Phase 2
23 ASRT Adaptive Source Routing Transparent Enhanced Bridge
26 DLS Data Link Switching
27 XTP X.25 Transport Protocol
28 APPN Advanced Peer-to-Peer Networking [HPR]
30 APPN Advanced Peer-to-Peer Networking [ISR]

```

```

Num Name Feature
2 MCF MAC Filtering

```

16 Networks:

Net	Interface	MAC/Data-Link	Hardware	State
0	TKR/0	Token-Ring/802.5	Token-Ring	Up
1	TKR/1	Token-Ring/802.5	Token-Ring	Up
2	TKR/2	Token-Ring/802.5	Token-Ring	Up
3	TKR/3	Token-Ring/802.5	Token-Ring	Up
4	Eth/0	Ethernet/IEEE 802.3	Ethernet	Up
5	Eth/1	Ethernet/IEEE 802.3	Ethernet	Up
6	Eth/2	Ethernet/IEEE 802.3	Ethernet	Up
7	Eth/3	Ethernet/IEEE 802.3	Ethernet	Up
8	Eth/4	Ethernet/IEEE 802.3	Ethernet	Up
9	Eth/5	Ethernet/IEEE 802.3	Ethernet	Up
10	FR/0	Frame Relay	V.35/V.36	Up
11	X25/0	X.25	V.35/V.36	Up
12	PPP/0	Point to Point	V.35/V.36	Up
13	PPP/1	Point to Point	V.35/V.36	Up
14	PPP/2	Point to Point	V.35/V.36	Up
15	PPP/3	Point to Point	V.35/V.36	Up

4. Enter the **GWCON network** command and the number of the interface you want to monitor. For example:

```
+ network 11
X.25>
```

In this example, the X.25 console prompt is displayed on the console. You can then view information about the X.25 interface by entering the X.25 console commands.

**Monitoring the Network Interface:** Refer to the specific chapters in this manual for complete information on monitoring your 2216's network interfaces.

## Accessing Feature Configuration and Operating Processes

To help you access the Multiprotocol Access Services feature configuration and operating processes, this section outlines both of these procedures.

### Accessing the Feature Processes

Use the **feature** command from the CONFIG process to access configuration commands for specific Multiprotocol Access Services features outside of the protocol and network interface configuration processes.

Use the **feature** command from the GWCON process to access console commands for specific features that are outside of the protocol and network interface console processes.

Enter a question mark after the **feature** command to display a listing of the features available for your software release. For example:

```
Config> feature ?
WRS
BRS
MCF
TSF
Feature name or number [1] ?
```

To access a particular feature's configuration or operating prompt, enter the **feature** command at the Config> or + (GWCON) prompt, respectively, followed by the feature number or short name. For example:

```
Config> feature mcf
MAC filtering user configuration
Filter Config>
```

Table 9 on page 91 lists the available feature numbers and names.

Once you access the configuration or operating prompt for a feature, you can begin entering specific commands for the feature. To return to the previous prompt level, enter the **exit** command at the feature's prompt.

## Accessing Protocol Configuration and Operating Processes

This section describes how to access the protocol configuration and operating processes.

### Entering a Protocol Configuration Process

To enter the desired protocol configuration process from the CONFIG> prompt:

1. At the CONFIG> prompt, enter the **list configuration** command to see the numbers and names of the protocols purchased in your copy of the software. See page 92 for sample output of the **list configuration** command.
2. From the Config> prompt, enter the **protocol** command with the number or short name (for example, SNMP) of the protocol you want to configure. The protocol number and short name is obtained from the **list configuration** command display. In the following example, the command has been entered for accessing the SNMP protocol configuration process:

```
Config> protocol SNMP
```

*or*

```
Config> protocol 11  
SNMP user configuration
```

The protocol configuration prompt then displays on the console. The following example shows the SNMP protocol configuration prompt:

```
SNMP config>
```

You can now begin entering the protocol's configuration commands. See the corresponding protocol section of the *Protocol Configuration and Monitoring Reference* for more information on specific protocol configuration commands.

In summary, the **protocol** command lets you enter the configuration process for the protocol software installed in your device. The **protocol** command enters a protocol's command process. After entering the protocol command, the prompt of the specified protocol appears. From the prompt, you can enter commands specific to that protocol.

### Entering a Protocol Operating Process

To enter a protocol console process from the GWCON prompt:

1. At the GWCON prompt, enter the **configuration** command to see the protocols and networks configured for the device. For example:

```
+configuration
```

```
Multiprotocol Access Services
```

```
2216-MAS Feature 2822 V3.2 Mod 0 PTF 0 RPQ 0 MAS.EF9 cc4_2a  
Num Name Protocol  
0 IP DOD-IP  
3 ARP Address Resolution  
4 DN DNA Phase IV  
6 VIN Banyan Vines  
7 IPX NetWare IPX  
10 BGP Border Gateway Protocol  
11 SNMP Simple Network Management Protocol  
12 OSPF Open SPF-Based Routing Protocol
```

```

22 AP2  AppleTalk Phase 2
23 ASRT Adaptive Source Routing Transparent Enhanced Bridge
26 DLS  Data Link Switching
27 XTP  X.25 Transport Protocol
28 APPN Advanced Peer-to-Peer Networking [HPR]
30 APPN Advanced Peer-to-Peer Networking [ISR]

```

```

Num Name Feature
2 MCF  MAC Filtering

```

```

16 Networks:
Net Interface MAC/Data-Link Hardware State
0 TKR/0 Token-Ring/802.5 Token-Ring Up
1 TKR/1 Token-Ring/802.5 Token-Ring Up
2 TKR/2 Token-Ring/802.5 Token-Ring Up
3 TKR/3 Token-Ring/802.5 Token-Ring Up
4 Eth/0 Ethernet/IEEE 802.3 Ethernet Up
5 Eth/1 Ethernet/IEEE 802.3 Ethernet Up
6 Eth/2 Ethernet/IEEE 802.3 Ethernet Up
7 Eth/3 Ethernet/IEEE 802.3 Ethernet Up
8 Eth/4 Ethernet/IEEE 802.3 Ethernet Up
9 Eth/5 Ethernet/IEEE 802.3 Ethernet Up
10 FR/0 Frame Relay V.35/V.36 Up
11 X25/0 X.25 V.35/V.36 Up
12 PPP/0 Point to Point V.35/V.36 Up
13 PPP/1 Point to Point V.35/V.36 Up
14 PPP/2 Point to Point V.35/V.36 Up
15 PPP/3 Point to Point V.35/V.36 Up

```

**Note:** APPN® is a registered trademark of IBM.

2. Enter the GWCON **protocol** command with the protocol number or short name of the desired protocol displayed in the configuration information.

In the following example, the command has been entered for accessing the SNMP protocol console process.

```
+ protocol 11
```

*or*

```
+ protocol SNMP
```

The protocol console prompt then displays on the console. This example shows the SNMP protocol console prompt:

```
SNMP>
```

You can now begin entering the protocol's commands. See the corresponding protocol section of the *Protocol Configuration and Monitoring Reference* for more information on specific protocol console commands.

---

## Command Completion

The automatic command completion function assists you with the syntax for commands entered at the command line.

To illustrate the behavior of Command Completion, assume that the following commands are allowed in a given menu context. (This is an example menu only.)

### enable

auto-refresh

caching

### set

cache-size

cache-timeout

priority

- If you type **ena** and press the Space Bar, the full command is shown as **ENABLE**. If you now type **?**, a list of possible items to enable are shown (**auto-refresh** and **caching**) and the command **ENABLE** remains on the command line.
- If you type **ena** and press **Enter**, a message is printed that the command is not fully specified, and a list of possible items to enable are shown (**auto-refresh** and **caching**) and the command **ENABLE** remains on the command line.
- Because the **ENABLE** command requires an item to enable, it appears in a list of possible command completions with “...” in the left margin to indicate that more input is required for the command.
- If your input matches multiple commands, a list of possible completions is displayed. Your input on the new command line is expanded to the longest common prefix. For example, if you enter **set ca**, and then press the space bar, **CACHE-SIZE** and **CACHE-TIMEOUT** will be listed, and the new command line will be expanded to **SET cache-**, since “cache-” is common to both possible completions. Now you must type the letter “s” or the letter “t” to distinguish between the possible completions “size” or “timeout”.
- Common commands sometimes appear in an alternate form (**SHOW, DISPLAY, LIST**). If the Command Completion does not yield a match on a common command, such as **SHOW**, the alternatives **DISPLAY** or **LIST** will be displayed, if found.
- If the search for a command (and alternatives) does not yield an exact match, you are presented with a list of possible completions, using some portion of your input. For example, **enable** followed by the Space Bar would be replaced with **ena** and **ENABLE** would be listed as the possible completion.
- When a list of possible commands is shown, you can use the Tab key to cycle through one command at a time on the current command line. You can use the Space Bar or Enter key to select the command shown.

## Online Help When Command Completion is Enabled

The following online help is available when command-completion is enabled.

See page 89 for the **enable command-completion** syntax.

**?** Question mark displays a list of possible completions. A message appears if the command is already complete.

### Space Bar

Attempts to complete the current word on the command line. If a unique match is not found, possible completions are listed.

**Tab** Attempts to complete the current word on the command line. If a unique match is not found, possible completions are listed and you may cycle through these possible completions using the Tab key. Use the Space Bar or the Enter key to select the currently displayed command.

**Enter** Attempts to complete the current word on the command line. If the command is complete, Enter executes the command and stores it in the Command History. If the command is incomplete, a list of possible completions is displayed.

**Ctrl-P** Returns to the MOS Operator Console prompt (\*). (Ctrl-P is the default Intercept Character.)

### Backspace

Deletes the last character on the command line.

- Ctrl-W** Deletes the last word on the command line.
- Ctrl-U** Aborts the current command.
- Ctrl-L** Refreshes the current command line to display its contents.
- Ctrl-B** Retrieve Backward. Replaces the current command line with the previous command in the circular Command History.
- Ctrl-F** Retrieve Forward. Replaces the current command line with the next command in the Command History.
- Ctrl-R** Marks the start of a Repeat Sequence in the Command History. Use with the **Ctrl-N** function.
- Ctrl-N** Replaces the current command line with the next command in the Repeat Sequence whose starting command was marked with **Ctrl-R**.
- Ctrl-C** Cancels Easy-Start, if active.

**Escape ?**

**Escape**, followed by “?” prints this Command Line Help:

The following rules apply to automatic command completion:

- Completed commands are shown in UPPERCASE on the command line.
- Common commands sometimes appear in an alternate form (**ADD** versus **CREATE**). If the command completion does not yield a match on a common command, any alternative commands will be displayed.
- If the search for a command (and alternative commands) does not yield a unique match, a list of possible completions is shown, and the longest common prefix is presented.
- When possible completions are listed, commands requiring further command input are shown with “...” in the left margin.
- When a Command History retrieve key (Ctrl-B,F,N) is pressed, the Command History is scanned for a command that successfully parses in the current command context. A tone will be sounded if no such command exists.
- Some command menus are built dynamically. Command Completion cannot always follow these dynamic links. ‘?’ can be entered in these cases.
- To disable Command Completion for just one command (to enter a comment), type any Comment Character as the first character on the command line. The Comment Characters are !@#%\*.:;/”
- Command Completion will be disabled in the event of an internal error. Report the Debug information on the screen to Customer Support.
- Command Completion is currently Enabled. To Disable this option, use the **disable command-completion** command from Configuration talk 6.

## Online Help When Command Completion is Disabled

The following online help is available when command-completion is disabled:

- ?** When a ? (Question Mark) is entered at the end of the command line, a list of possible completions is shown.
- Enter** Executes the command and stores it in the Command History. A message is printed if the command is not fully specified
- Ctrl-P** Returns to the MOS Operator Console prompt (\*). (Ctrl-P is the default Intercept Character.)

**Backspace**

Deletes the last character on the command line.

**Ctrl-U** Aborts the current command.

**Ctrl-B** Retrieve Backward. Replaces the current command line with the previous command in the circular Command History.

**Ctrl-F** Retrieve Forward. Replaces the current command line with the next command in the Command History.

**Ctrl-R** Marks the start of a Repeat Sequence in the Command History. Use with the **Ctrl-N** function.

**Ctrl-N** Replaces the current command line with the next command in the Repeat Sequence whose starting command was marked with **Ctrl-R**.

**Ctrl-C** Cancels Easy-Start, if active.

**Escape ?**

**Escape**, followed by “?” prints this Command Line Help:

Command Completion is currently Disabled. To Enable this option, use the **enable command-completion** command from Configuration talk 6.

---

## Command History

The Command History contains up to the last 50 commands entered by the user in OPCON, GWCON (Talk 5) or CONFIG (Talk 6) command line menus.

Backward and Forward retrieve keys can be used to recall previously entered commands. In addition, a facility is provided to enable the advanced user to repeat a particular series of commands.

## Repeating a Command in the Command History

By pressing **Ctrl-B** (backward) or **Ctrl-F** (forward) at any command line prompt in an OPCON, GWCON or CONFIG menu, the current command line is replaced by the previous or next command in the Command History. The Command History is common across the command line interface. That is, a command entered while in a GWCON menu can be retrieved from within CONFIG and a command entered while in a CONFIG menu can be retrieved from within GWCON.

When automatic Command Completion is enabled (See “Command Completion” on page 22) and a Command History retrieve key (Ctrl-B,F,N) is pressed, the Command History is scanned for a command that successfully parses in the current command context. A tone will be sounded if no such command exists.

The Command History contains the most recently entered commands, up to a maximum of the last 50 commands. If only three commands have been entered since a reload, pressing **Ctrl-F** or **Ctrl-B** circles through only those three commands. If no commands have been entered thus far, **Ctrl-F** or **Ctrl-B** results in tone sound.

**Note:** A command aborted by pressing **Ctrl-U** will not be entered into the Command History. When Command Completion is enabled, only complete commands are entered into the Command History.



To enter two similar commands:

```
display sub les
display sub lec
```

Enter:

```
display sub les, then press Enter
Ctrl-B for Backward, and the current line is replaced with-
display sub les
Press Backspace and replace "s" with "c" to get
display sub lec and then press Enter
```

## Repeating a Series of Commands in the Command History

There is an additional feature for advanced users to facilitate repeating a particular series of GWCON or CONFIG commands. C1, C2,...,Cn in the Command History is referred to as a *repeat sequence*. This feature may be more convenient than simply using **Ctrl-B** and **Ctrl-F** when you must repeat a given task that requires multiple commands. Enter **Ctrl-R** (repeat) to set the start of the *repeat sequence* at command C1. Enter **Ctrl-N** (next) successively to retrieve the next command in the repeat sequence. Commands are not automatically entered, but are placed on the current command line allowing you to modify or enter the command.

To produce the desired behavior of a repeat sequence, the first command retrieved using the first **Ctrl-N** (next) depends on the manner in which the start of the repeat sequence was set using **Ctrl-R** (repeat).

Setting the start of the repeat sequence with **Ctrl-R** can be done in two ways:

1. When C1 is initially entered
2. When C1 is retrieved from the Command History with **Ctrl-B** or **Ctrl-F**.

### Starting a Repeat Sequence As Commands Are Entered

If you enter **Ctrl-R** as command C1 is being keyed in, and then enter commands C2, C3... Cn. **Ctrl-N** will successively bring commands C1, C2, ... Cn, C1, C2, ... Cn, C1, ... to the command line.

In Example 1, the start of the repeat sequence is set as the first command is keyed in. The user knows ahead of time that the same commands to be entered in GWCON need to be repeated in CONFIG.

#### Example 1

1. As the first command in the sequence is keyed in, use **Ctrl-R** (repeat) to set the start of the repeat sequence.

```
*console
+event Ctrl-R
```

then press **Enter** to set the start of the repeat sequence.

2. Continue typing the subsequent commands in the sequence:

```
Event Logging System user console
ELS>display sub les
ELS>display sub lec
ELS>exit
+
```

3. To enter these same commands in CONFIG, press **Ctrl-P** (the default OPCON intercept character) and go to CONFIG.



```

+-press Ctrl-P-
*configuration
Config>Ctrl-N for NEXT to retrieve the start of this sequence-
Config>event Enter
Event Logging System user configuration
ELS config>Ctrl-N for NEXT to retrieve the next command in sequence-
ELS config>display sub les Enter
ELS config>Ctrl-N for NEXT to retrieve the next command in sequence-
ELS config>display sub lec Enter
ELS config>Ctrl-N for NEXT to retrieve the next command in sequence-
ELS config>exit Enter
Config>

```

### Starting a Repeat Sequence After All Commands Are Entered

On the other hand, if you first enter C1, C2, ... Cn, and retrieve C1 via **Ctrl-B** or **Ctrl-F**. Entering **Ctrl-R**, entering **Ctrl-N** successively brings commands C2,..., Cn, C1, C2,..., Cn, C1,...,Cn to the command line (see Example 2). The first occurrence of C1 is bypassed since C1 is already available on the command line at the time it was retrieved, and does not need to be recalled again by the first **Ctrl-N**.

In Example 2, all the commands are entered and then the first command in the sequence to be repeated is retrieved. A sequence of commands has been entered in GWCON, and the same sequence needs to be repeated in CONFIG.

### Example 2

1. Enter the following commands in GWCON:

```

*console
+event
Event Logging System user console
ELS>display sub les
ELS>display sub lec
ELS>exit
+

```

2. To enter these same commands in CONFIG, press **Ctrl-P** (the default OPCODE intercept character) and go to CONFIG.

```

+Ctrl-P-
*configuration
Config>Ctrl-B four times to retrieve the start of
the four command sequence in this example-
Config>event
Config>event Ctrl-R for REPEAT to set the start of the repeat sequence-
Config>event Enter
Event Logging System user configuration
ELS config>Ctrl-N for NEXT to retrieve the next command in sequence-
ELS config>display sub les Enter
ELS config>Ctrl-N for NEXT to retrieve the next command in sequence-
ELS config>display sub lec Enter
ELS config>Ctrl-N for NEXT to retrieve the next command in sequence-
ELS config>exit Enter
Config>

```



---

## Chapter 3. Accessing the Firmware from the Command Line Interface

This section covers boot options that can be set from the Firmware and Operational command prompt. For information about file transfer and file management, refer to *IBM 2216 Nways Multiaccess Connector Installation and Initial Configuration Guide*.

The 2216 is designed to boot from one of the integrated image banks. With the hard drive installed, the 2216 has two image banks that can be used to IML or boot the device. The 2216 also has options to come up in Attended or Unattended mode. Attended mode requires direct interaction with a user at a console attached on the serial port.

The device can be booted from the hard drive, known as Bank A and B.

---

### Accessing the Firmware Prompt

Before booting the router, note that:

- You will need a terminal or IP workstation connected to the 2216. This can be a VT100 TTY device connected directly through the serial port. You can connect an IP workstation using SLIP to connect into the 2216. The default 2216 IP address is 10.1.1.2 and the workstation address should be 10.1.1.3.

**Important:** To access the Firmware prompt, you can stop the 2216 boot. To stop it, you must have a TTY console directly attached to the serial port. When the 2216 starts its boot sequence, press **Ctrl-C** from the console to interrupt the boot sequence.

Another way to control booting is to configure the 2216 to come up in Attended mode. Attended mode can be configured from the Firmware command set.

---

### Boot Options Available for the 2216

The 2216 can be configured for Unattended mode. In Unattended mode, you must have chosen which load image and which configuration to load. You are provided with two banks to choose from. The structure of the image banks is as follows:

- IMAGE - Status of image
- CONFIG 1 - Status of Config
- CONFIG 2 - Status of Config
- CONFIG 3 - Status of Config
- CONFIG 4 - Status of Config

See "List" on page 55 for a description of file statuses.

### Attended Mode

When the 2216 is configured to come up in Attended mode, you are given access to the Firmware command set. From this level of commands, you can select the Image Bank from which to load and the config. You can at this point load new config files or image files. This connection is either a TTY or Telnet connection. You can transfer files using the Xmodem protocol for TTY or TFTP for IP connections.

**Important:** In release 2, multiple load modules make up a single device load. If you are transferring a load into a bank using XMODEM, you must transfer the files individually. The following applies:

1. Transfer LML.Id first
2. You must ensure all files that make up the load transfer successfully. When there is an error transferring a file, you will receive a message box containing "ERROR WRITING FILE". Otherwise, you can assume the file has transferred successfully.
3. When all files have transferred, the status of the bank will change from "Corrupt" to "Avail".

In Attended mode, you can start booting the 2216 by pressing **F9** or **<Esc>9** to start the operating system.

## Unattended Mode

This is the normal mode for the 2216. It will come up on the Active, Local, or Pending image and config based on your choice.

---

## Chapter 4. The OPCON Process and Commands

This chapter describes the OPCON interface configuration and operational commands. It includes the following sections:

- “What is the OPCON Process?”
- “Accessing the OPCON Process”
- “OPCON Commands”

---

### What is the OPCON Process?

The Operator Console process (OPCON) is the root-level process of the device software user interface. The main function of OPCON is to communicate with processes at the secondary level, such as Configuration, Console, and Event Logging. Using OPCON commands, you may also:

- Display information about device memory usage
- Reload the device software (reboot)
- Telnet or ping to other devices or hosts
- Display status information about all device processes
- Manipulate the output from a process
- Change the OPCON intercept character

---

### Accessing the OPCON Process

When the device starts for the first time, a boot message appears on the console. Then the OPCON prompt (\*) appears on the console, indicating that the OPCON process is active and ready to accept commands.

The OPCON process allows you to configure, change, and monitor all of the device’s operating parameters. While in the OPCON process, the device is forwarding data traffic. When the device is booted and enters OPCON, a copyright logo and an asterisk (\*) prompt appears on the locally attached console terminal. This is the OPCON (OPerator’s CONsole) prompt, the main user interface that allows access to second-level processes.

Some changes to the device’s operating parameters made while in OPCON take effect immediately without requiring reinitializing of the device. If the changes do not take effect, use the **reload** command at the \* prompt.

At the \* prompt, an extensive set of commands enables you to check the status of various internal software processes, monitor the performance of the device’s interfaces and packet forwarders, and configure various operational parameters.

---

### OPCON Commands

This section describes the OPCON commands. Commands that are needed more often appear before the “- - - -” separator. Each command includes a description, syntax requirements, and an example. The OPCON commands are summarized in Table 4. To use them, access the OPCON process and enter the appropriate command at the OPCON prompt (\*).

*Table 4. OPCON Commands*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.

Table 4. OPCON Commands (continued)

Command	Function
Configuration*	Accesses the device's configuration process. (talk 6)
Console*	Accesses the device's console process. (talk 5)
Event Logging System*	Accesses the device's event logging process. (talk 2)
ELS Console*	Accesses the device's secondary ELS Console process. (talk 7)
Logout	Logs off a remote console.
Ping	Pings a specified IP address.
Reload	Reloads the device.
Telnet	Connects to another device.
-----	-----
Diags	Displays device status and the contents of the hardware test log and the hardware error log.
Divert	Sends the output from a process to a console or other terminal.
Flush	Discards the output from a process.
Halt	Suspends the output from a process.
Intercept	Sets the OPCON default intercept character.
Memory	Reports the device's memory usage.
Status	Shows information about all device processes.
Suspend	Temporarily disables Command Completion for the current session only.
Talk	Connects to another device process and enables the use of its commands.

\* When you use this command for the first time, you will be reminded that you can use **Ctrl-P** to return to the MOS Operator Console prompt (\*).

## Configuration

Use the **configuration** command to access the device's configuration process (talk 6). See "Chapter 7. The CONFIG Process (CONFIG - Talk 6) and Commands" on page 63 for more information.

### Syntax:

**configuration**

### Example:

\* **configuration**

(To return to the MOS Operator Console prompt (\*), press Control-P)

```
Gateway user configuration
Config>
```

## Console

Use the **console** command to access the device's console and monitoring process (talk 5). See "Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands" on page 109 for more information.

### Syntax:

**console**

### Example:

```
* console
CGW Operator Console
+
```

## Diags

Use the **diags** command to display the Diagnostic Main Menu. The diagnostic menus allow you to enable, disable and test hardware adapters or ports. Diagnostic menus have on-screen help for the various options and status information that is available.

You can use the “b” (back) key to return to any previous menu. Use the “e” (exit) key to exit the diagnostics and return to the OPCON command prompt.

See the *Service and Maintenance Manual* for the 2216 for more information on diagnostic support.

### Syntax:

**diags**

## Divert

Use the **divert** command to send the output from a specified process to a specified terminal. This command allows you to divert the output of several processes to the same terminal to simultaneously view the output. The **divert** command is commonly used to redirect MONITR output messages to a specific terminal. The device allows only certain processes to be redirected.

The **divert** command requires the PID and tty# (number of the output terminal). To obtain these values, use the OPCON **status** command. The terminal number can be the number of either the local console (tty0) or one of the remote consoles (tty1, tty2). The following example shows Event Logging System messages generated by the MONITR process (2) being sent to a remote console *tty1* (1).

Event messages are displayed immediately even though you may be in the middle of typing a command. The display and keyboard have separate buffers to prevent command confusion. The following example shows the MONITR process connected to TTY0 after executing the **divert 2 0** command. If you want to stop the output, enter **halt 2**. The **halt** command is described in “Halt” on page 34.

### Syntax:

**divert** *pid tty#*

### Example:

```
Copyright Notices:
Copyright IBM Corp. 1994, 1997
MOS Operator Console
```

For help using the Command Line Interface, press ESCAPE, then '?'

```
* divert 2 0

* status
Pid Name      Status TTY  Comments
1  COpCN1     IOW  TTY0 gzs
2  Monitr     IDL  TTY0
3  Tasker     RDY  --
4  MOSDBG     DET  --
```

```

5  CGWCon  DET  --
6  Config  DET  --
7  ELSCon  DET  --
8  ROpCN1  IDL  TTY1
9  ROpCN2  RDY  TTY2 j1g@128.185.40.40

```

## Els

Use the **els** command to access the device's secondary ELS console process, (talk 7). See "Accessing the Secondary ELS Console Process, ELSCon (Talk 7)" on page 15 for more information.

### Syntax:

els

## Event

Use the **event** command to access the device's event logging process, (talk 2). See "Chapter 10. Using the Event Logging System (ELS)" on page 127 for more information.

### Syntax:

event

## Flush

Use the **flush** command to clear the output buffers of a process. This command is generally used before displaying the contents of the MONITR's FIFO buffer to prevent messages from scrolling off the screen. Accumulated messages are discarded.

The device allows only certain processes to be flushed. To obtain the PID and tty#, use the OPCON **status** command. In the following example, after executing the **flush 2** command, the output of the MONITR process is sent to the Sink (it has been flushed).

### Syntax:

flush *pid*

### Example:

```

* flush 2
* status
Pid Name      Status TTY  Comments
1  COpCN1     IOW  TTY0
2  Monitr     IDL  SNK
3  Tasker     RDY  --
4  MOSDBG     DET  --
5  CGWCon     DET  --
6  Config     DET  --
7  ELSCon     DET  --
8  ROpCN1     IDL  TTY1
9  ROpCN2     RDY  TTY2 j1g@128.185.40.40

```

## Halt

Use the **halt** command to suspend all subsequent output from a specified process until the **divert**, **flush**, or **talk** OPCON command is issued to the process. The device cannot redirect all processes. **Halt** is the default state for output from a process. To obtain the PID for this command, use the OPCON **status** command. In the following example, after executing the **halt 2** command, the MONITR process is no longer connected to TTY0. Event messages no longer appear.



**Syntax:****halt** *pid***Example:**

```
* halt 2
* status
Pid Name      Status TTY Comments
1  COpCN1    IOW  TTY0 gzs
2  Monitr    IDL  --
3  Tasker    RDY  --
4  MOSDBG    DET  --
5  CGWCon    DET  --
6  Config    DET  --
7  ELSCon    DET  --
8  ROpCN1    IDL  TTY1
9  ROpCN2    RDY  TTY2 jlg@128.185.40.40
```

## Intercept

Use the **intercept** command to change the OPCON intercept character. The intercept character is what you enter from other processes to get back to the OPCON process. The default intercept key combination is **Ctrl-P**.

The intercept character can be a control character. Enter the ^ (shift 6) character followed by the letter character or non-alphanumeric character, such as !@#\$, you want for the intercept character.

**Note:** This change applies to only the current login session.

**Syntax:****intercept** *^ character***Example 1:**

```
* intercept ^a
```

From this example, the intercept character is now **Ctrl-A**.

**Example 2:**

```
* intercept !
```

From this example, the intercept character is now **!**.

## Logout

Use the **logout** command to terminate the current session for the user who enters the logout command. If the console login is enabled, this command will require the next user to log in using an authorized userid/password combination. If the console login is not enabled, the OPCON prompt appears again.

**Syntax:****logout**

## Memory

Use the **memory** command to obtain and display information about the device's global heap memory usage. The display helps you to determine if the device is being utilized efficiently. For an example of memory utilization, see Figure 3 on page 36.

See “Memory” on page 118 for memory usage via talk 5.

**Syntax:**

**memory**

**Example:**

```
* memory
Number of bytes: Busy = 319544, Idle = 1936, Free = 1592
```

**Busy** Specifies the number of bytes currently allocated.

**Idle** Specifies the number of bytes previously allocated but freed and available for reuse.

**Free** Specifies the number of bytes that were never allocated from the initial free storage area.

**Note:** The sum of the Idle and Free memory equals the total available heap memory.

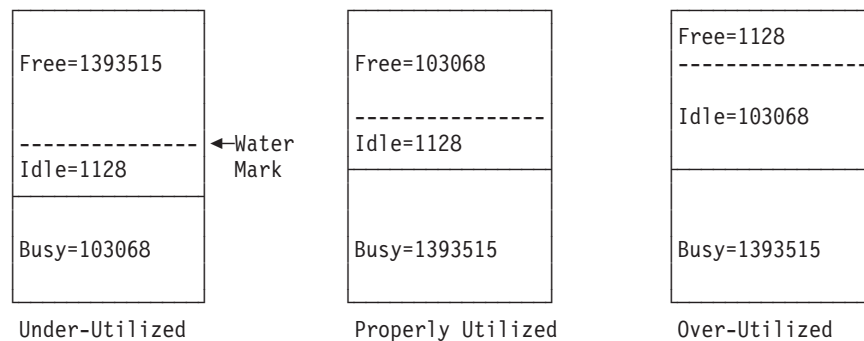


Figure 3. Memory Utilization

## Ping

Use the **ping** command to have the device send ICMP Echo messages to a given destination (that is, “pinging”) and watch for a response. This command can be used to isolate trouble in the internetwork.

**Syntax:**

**ping** *dest-addr [src-addr data-size ttl rate tos data-value]*

The ping process is done continuously, incrementing the ICMP sequence number with each additional packet. Each matching received ICMP Echo response is reported with its sequence number and the round-trip time. The granularity (time resolution) of the round-trip time calculation is usually around 20 milliseconds, depending on the platform.

To stop the ping process, type any character at the console. At that time, a summary of packet loss, round-trip time, and number of unreachable ICMP destinations will be displayed.

When a broadcast or multicast address is given as destination, there may be multiple responses printed for each packet sent, one for each group member. Each returned response is displayed with the source address of the responder.

You can specify the size of the ping (number of data bytes in the ICMP message, excluding the ICMP header), value of the data, time-to-live (TTL) value, rate of pinging, and TOS bits to set. You can also specify the source IP address. If you do not specify the source IP address, the device uses its local address on the outgoing interface to the specified destination. If you are validating connectivity from any of the device's other interfaces to the destination, enter the IP address for that interface as the source address.

Only the destination parameter is required; all other parameters are optional. By default the size is 56 bytes, the TTL is 64, the rate is 1 ping per second, and the TOS setting is 0. The first 4 bytes of the ICMP data are used for a timestamp. By default the remaining data is a series of bytes with values that are incremented by 1, starting at X'04', and rolling over from X'FF' to X'00' (for example, X'04 05 06 07 . . . FC FD FE FF 00 01 02 03 . . .'). These values are incremented only when the default is used; if the data byte value is specified, all of the ICMP data (except for the first 4 bytes) is set to that value and that value is not incremented. For example, if you set the data byte value to X'FF', the ICMP data is a series of bytes with the value X'FF FF FF . . . '.

#### Example:

```
* ping
Destination IP address [0.0.0.0]? 192.9.200.1
Source IP address [192.9.200.77]?
Ping data size in bytes [56]?
Ping TTL [64]?
Ping rate in seconds [1]?
Ping TOS (00-FF) [0]? e0
Ping data byte value (00-FF) [ ]?
PING 192.9.200.77-> 192.9.200.1:56 data bytes,ttl=64,every 1 sec.
56 data bytes from 192.9.200.1:icmp_seq=0.ttl=255.time=0.ms
56 data bytes from 192.9.200.1:icmp_seq=1.ttl=255.time=0.ms
56 data bytes from 192.9.200.1:icmp_seq=2.ttl=255.time=0.ms

----192.9.200.1 PING Statistics----
3 packets transmitted, 3 packets received, 0% packet loss
round-trip min/avg/max=0/0/0 ms
```

## Reload

Use the **reload** command to reboot the device by loading in a new copy of the device software. When you use this command from a remote console, you install a new software load without going to the device. This command executes the same functions as pressing the reset button except that the device will not dump (if so configured). Before the reload takes effect, you are prompted to confirm the reload. You are also prompted if you have not saved the configuration changes.

#### Syntax:

**reload**

#### Example:

```
* reload
Are you sure you want to reload the gateway (Yes or No)?
```

## Status

Use the **status** command to display information about all device processes. By entering the PID after the **status** command, you can look at the status of only the desired process. The following example shows the total status display.

#### Syntax:

**status** *pid*

**Example:**

```
* status
  Pid Name      Status TTY Comments
1   COpCN1    IOW  TTY0
2   Monitr    IDL  --
3   Tasker    RDY  --
4   MOSDBG    DET  --
5   CGWCon    IOW  --
6   Config    IOW  TTY1
7   ELSCon    DET  --
8   ROpCN1    IOW  TTY1 128.185.46.101
9   ROpCN2    RDY  TTY2 128.185.46.104
```

**Pid** Specifies the PID. This is the process to talk to from OPCON, or it can be an argument to the STATUS command to request status information about a specific process.

**Name** Specifies the process name. It usually corresponds to the name of the program that is running in the process.

**Status**

Specifies one of the following:

**IDL** Specifies that the process is idle and waiting for completion of some external event, such as asynchronous I/O.

**RDY** Specifies that the process is ready to run and is waiting to use the CPU.

**IOW** Specifies that the process is waiting for synchronous I/O, usually its expected standard input, to complete.

**DET** Specifies that the process has output ready to be displayed and it is either waiting to be attached to a display console or waiting to have its output diverted to a specified console.

**FZN** Specifies that the process is frozen due to an error. This usually means the process is trying to use a device which is faulty or incorrectly configured.

**TTY $n$**  Specifies the output terminal, if any, to which the process is currently connected.

**TTY0** Local console

**TTY1 or TTY2**  
Telnet consoles.

**Sink** Process has been flushed.

**Two dashes (--)**  
Process has been halted.

**Comments**

Specifies the user's login IP address provided during login when a user is logged in using Telnet (ROpCon).

## Suspend

Use the **suspend** command to temporarily disable Command Completion for the current session only. If you are using an automated script, you can issue **suspend yes** as the first command if you want to temporarily disable Command Completion.

For information about Command Completion, see “Command Completion” on page 22 .

**Syntax:**

suspend

## Talk

You can use the **configuration**, **console**, or **event** commands to connect to other processes, such as CONFIG, GWCON, or MONITR, or use the **talk** command. After connecting to a new process, you can send specific commands to and receive output from that process. You cannot talk to the TASKER or OPCON processes.

To obtain the PID, use the OPCON **status** command. Once you are connected to the second-level process, such as CONFIG, use the intercept character, **Ctrl-P**, to return to the \* prompt.

**Syntax:**

talk *pid*

**Example:**

```
* talk 5
```

```
CGW Operator Console
```

```
+
```

When using third-level processes, such as SNMP Config> or SNMP>, use the **exit** command to return to the second level.

## Telnet

Use the **telnet** command to remotely attach to another device or to a remote host. The only optional parameter is the terminal type that you want to emulate.

You can use the **telnet** command with IPv4 or with IPv6 addresses.

A device has a maximum of five Telnet sessions: two servers (inbound to the device), and three clients (outbound from the device).

**Note:** To use Telnet in a pure bridging environment, enable Host Services.

**Syntax:**

telnet *ip-address terminal-type*

**Example 1:** `telnet 128.185.10.30` or `telnet 128.185.10.30 23` or `telnet 128.185.10.30 vt100`

```
Trying 128.185.10.30 ...
Connected to 128.185.10.30
Escape character is '^]
```

**Example 2:** `telnet 1:9::10`

```
Trying 1:9::10 ...
Connected to 1:9::10
Escape character is '^]
```

When Telneting to a non-existent IP address, the device displays:

Trying 128.185.10.30 ...

To enter the Telnet command mode, type the escape character-sequence, which is **Ctrl-]**, at any prompt.

```
telnet>
```

If you Telnet into a device,

- Press **← Backspace** to delete the last character typed on the command line.

**Note:** When using a VT100 terminal, do not press **← Backspace** because it inserts invisible characters. Press **Delete** to delete the last character.

- Press **Ctrl-U** at the `telnet>` prompt to delete the whole command line entry so that you can reenter a command.

The Telnet command mode consists of the following subcommands:

**close** Close current connection

**display**

Display operating parameters

**mode** Try to enter line-by-line or character-at-a-time mode

**open** Connect to a site

**quit** Exit Telnet

**send** Transmit special characters (send ? for more)

**set** Set operating parameters (set ? for more)

**status** Print status information

**toggle** Toggle operating parameters (toggle ? for more)

**z** Suspend Telnet

**?** Print help information

The **status** and **send** subcommands have one of two responses depending on whether or not the user is connected to another host. For example:

Connected to a host:

```
telnet> status
Connected to 128.185.10.30  Operating in character-at-a-time mode.  Escape character is ^].

telnet> send ayt
```

**Note:** The send command currently supports only ayt.

Not connected to a host:

```
telnet> status
Need to be connected first.

telnet> send ayt

Need to be connected first.
```

Use the **close** subcommand to close a connection to a remote host and terminate the Telnet session. Use the **quit** subcommand to exit the **telnet** command mode, close a connection, and terminate a Telnet session.

```
telnet> close
```

*or*

```
telnet> quit
```

```
logout
```

```
*
```





---

## Part 2. Understanding, Configuring, and Using Base Services



---

## Chapter 5. Using BOOT Config to Perform Change Management

This chapter describes how to use the Boot/Dump Configuration process. This chapter includes the following sections:

- “Understanding Change Management”
- “Using the Trivial File Transfer Protocol (TFTP)”
- “Loading an Image at a Specific Time” on page 47

---

### Understanding Change Management

Change management is the handling of software and configuration data for an IBM 2216. This involves:

1. Moving code and configuration data to and from the IBM 2216
2. Moving code and configuration data on the IBM 2216 persistent storage device, which is a disk drive.
3. Selecting and activating specific combinations of software and configuration.

The change management functions are available by entering the **boot** command at the `Boot config>` prompt (talk 6), or the firmware should the box be in a condition where the hard drive or compact flash does not contain viable software (that is, you cannot access talk 6).

The IBM 2216 code and configuration data storage resource is divided into areas called “system banks” (banks for short), each containing a single version of the operational code and any other files pertinent to that release of the code. Up to four configuration files are associated with each bank’s software.

The general change management model of the IBM 2216 is to introduce new code and/or configuration data to the system while the system runs at its present level and then activate the changed code or configuration data set later. If for some reason the new code or configuration does not function as expected, you have the ability to revert to the previous version of the configuration.

---

### Using the Trivial File Transfer Protocol (TFTP)

TFTP is a file transfer protocol that runs over the Internet UDP protocol. This implementation provides multiple, simultaneous TFTP file transfers between an IBM 2216’s non-volatile configuration memory, image bank, and remote hosts.

TFTP allows you to:

- Get a configuration file from a server to an IBM 2216
- Put a configuration file from an IBM 2216 to a server
- Get load modules from a server to an IBM 2216
- Put load modules from an IBM 2216 to a server

TFTP transfers involve a *client* node and a *server* node. The client node generates a TFTP Get or Put request onto the network. The IBM 2216 acts as a client node by generating TFTP requests from the IBM 2216 console using the `Boot config>` process **tftp** command.

The client can transfer a copy of a configuration file or image file stored in the image bank of a server.

## Using BOOT Config

The server is any device (for example, a personal computer or workstation) that receives and services the TFTP requests. When the IBM 2216 acts as a server, transfers are transparent to the user. Use the ELS subsystem TFTP message log to view the transfer in progress.

## Transferring Large Amounts of Data to Multiple Files

This function is important for situations where the receiving TFTP server has a bug handling the block count wrapping back to zero or having a value of 0x8000. The TFTP protocol requires that a block count be transmitted with every data block. The acknowledgement for that data block carries the block number that was in the data block being acknowledged. The transmitter of the data won't send any more data until it receives an acknowledgement for the last data block sent. Once the receiver of the data sends the acknowledgement it expects to receive a data block with a block count that is one greater than the block count it previously received. This block count is two bytes long.

Some TFTP servers have improperly implemented this as a signed short word (two-byte variable where the high order bit being 1 indicates a negative value) and others as an unsigned long word (four byte variable).

If the amount of data to be transferred is so great that the block count wraps, then depending on how the receiver verifies the block count, it may or may not acknowledge the data. If the receiver uses a signed short, the problem will be experienced when the block count goes from 0x7ffff to 0x8000. If the receiver uses an unsigned long or short, the problem will be experienced when the block count goes from 0xffff to 0x0000. In both cases the block count in the data block will appear to be less than the previously received block count and the receiver gets confused.

The transmitting TFTP on the device will either receive an error packet or time out waiting for the receiver to respond. When this happens, TFTP on the device will realize that the block count had wrapped and will automatically recover by making a write request to the receiver for a new file. The new file name is derived from the original file name. The new file name is derived by overlaying the last two characters of the original file name with two decimal digits. Every time the block count wraps, a new file will be written until all the data has been transferred. Tools like **cat** can be used at the receiver to concatenate the files.

## Specifying the Maximum Number of Blocks to Transfer to a File at the Receiver

A patch variable was added so that you can specify the maximum number of blocks to transfer to a file at the receiver. This allows you to tell the device to automatically do a write request for a new file once the number of blocks specified has been sent. Doing this circumvents the automatic recovery described above, speeding up the transfer by avoiding the 5 minute timeout period.

The only values that may be specified for this patch variable are: 0xffff (65535) and 0x7fff (32767).

This patch variable is useful if you know that the receiving server has problems handling the wrap of the block count.

---

## Loading an Image at a Specific Time

There may be occasions when you may want to load a device on a specific day and time when you will be unavailable. You can configure the device to perform a timed load using the **timeload activate** command. Other commands allow you to view a device's scheduled load information or cancel a scheduled load. See "Change Management Configuration Commands" on page 49 for information on these commands.



---

## Chapter 6. Configuring Change Management

This chapter describes the Change management configuration commands. It includes the following sections:

- “Accessing the Change Management Configuration Environment”
- “Change Management Configuration Commands”

---

### Accessing the Change Management Configuration Environment

To enter the change management configuration command environment, use the CONFIG **boot** command. When the device’s software is initially loaded, it is running in the OPCON process, signified by the \* prompt. From the \* prompt:

1. Enter **talk 6**.
2. At the Config> prompt, type **boot**.

To return to the CONFIG process, type **exit**.

---

### Change Management Configuration Commands

This section describes the Change Management Configuration commands. Each command includes a description, syntax requirements, and an example. Table 5 summarizes the Change Management Configuration commands.

After accessing the Change Management Configuration environment, enter the configuration commands at the Boot config> prompt.

*Table 5. Change Management Configuration Commands*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Adds an optional description to a configuration file.
Copy	Copies boot files and configuration files to or from banks.
Describe	Displays information about the stored loadfile images.
Disable	Turns off various change management functions.
Enable	Turns on various change management functions.
Erase	Erases a stored image or a configuration file.
List	Displays information about configuration files and scheduled load information.
Lock	Prevents the device from overwriting the selected configuration with any other configuration.
Set	Selects code bank and configuration to be used.
Tftp	Initiates TFTP file transfers between the IBM 2216 and remote servers.
Timedload	Schedules a load into the device on a specific day and time, cancels a scheduled load, or displays scheduled load information.
Unlock	Removes the lock from a configuration allowing the configuration to be updated by the device.
Update Firmware	Installs the Firm.Id load module that you have received on either Bank A or Bank B of your 2216
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## Add

Use the **add** command to add an optional description to a configuration file.

### Syntax:

```
add configuration file description
load image description
```

### Example: Boot config> add

```
+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE                |                               | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 01:26 |
| CONFIG 2 - AVAIL *          | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 3 - AVAIL            |                               | 01 Jan 1970 01:39 |
| CONFIG 4 - AVAIL            |                               | 01 Jan 1970 01:52 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE              |                               | 01 Jan 1970 00:30 |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL            |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL            |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *         |                               | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked
```

```
Select the source bank: (A, B): [A]
Select the source configuration: (1, 2, 3, 4): [1] 3
Enter the description of the file: () New config for today
```

Attempting to set description for bank A configuration 3.

Operation completed successfully.

### Boot config>list

```
+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE                |                               | 01 Jan 1970       |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:58 |
| CONFIG 2 - AVAIL *          | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE             | New config for today         | 09 Jan 1970 00:58 |
| CONFIG 4 - AVAIL            |                               | 01 Jan 1970 01:05 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE              |                               | 01 Jan 1970       |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL            |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL            |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *         |                               | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked

Auto-boot mode is enabled. Fast-boot mode is disabled.
```

## Copy

Use the **copy** command to copy configuration files and load images to and from the banks.

**Note:** You can use the **copy bank** command to copy an entire bank, which is convenient if you want to use one bank as a backup for another bank.

### Syntax:

```
copy bank
configuration file
```

### Example:





to: bank A.

Operation completed successfully.

**Example: Boot config>copy**

BankA	Description	Date
IMAGE - CORRUPT		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 01:26
CONFIG 2 - AVAIL *	test config for pubs	01 Jan 1970 01:13
CONFIG 3 - AVAIL		01 Jan 1970 01:39
CONFIG 4 - AVAIL		01 Jan 1970 01:52

BankB	Description	Date
IMAGE - ACTIVE		01 Jan 1970 00:01
CONFIG 1 - AVAIL		01 Jan 1970 00:14
CONFIG 2 - AVAIL		01 Jan 1970 00:01
CONFIG 3 - AVAIL		01 Jan 1970 00:37
CONFIG 4 - ACTIVE *		01 Jan 1970 00:24

\* - Last Used Config      L - Config File is Locked

```
Select the source bank: (A, B): [A]
Select the source configuration: (1, 2, 3, 4): [1]
Select the destination bank: (A, B): [B]

Select the destination configuration: (1, 2, 3, 4): [1]
Copy SW configuration from: bank A, configuration 1
                           to: bank B, configuration 1.
/hd0/sys0/CONFIG0 --> /hd0/sys1/CONFIG0

Operation completed successfully.
```

If the copy fails you may receive one of the following messages:

**Error: Active bank cannot be overwritten or erased.**

You attempted to copy a configuration into the bank currently in use by the IBM 2216.

**Error: File copy failed.**

This condition occurs when the copy operation fails for reasons other than copying to the active configuration. The most common cause is specifying the same source and destination configurations. When you list (see "List" on page 55) the configurations, CORRUPT appears next to the bank that is damaged.

## Describe

Use the **describe** command to display information about a stored image.

**Syntax: describe**

**Example: Boot config>describe**

BANK A	BANK B
Product ID - 2216-MAS	Product ID - 2216-MAS
Version 3 Release 2	Version 3 Release 2
Mod 0 PTF 0	Mod 0 PTF 0
Feat. 2822 RPQ 0	Feat. 2822 RPQ 0
Date 31 Dec 1996	Date 31 Dec 1996

## Disable

Use the **disable** command to turn off various change management functions.

**Syntax:**



**Example: Boot config>erase load**

BankA	Description	Date
IMAGE - CORRUPT		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 01:26
CONFIG 2 - AVAIL *	test config for pubs	01 Jan 1970 01:13
CONFIG 3 - NONE		01 Jan 1970 00:58
CONFIG 4 - AVAIL		01 Jan 1970 00:39

BankB	Description	Date
IMAGE - ACTIVE		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:54
CONFIG 2 - AVAIL		01 Jan 1970 00:01
CONFIG 3 - AVAIL		01 Jan 1970 00:14
CONFIG 4 - ACTIVE *		01 Jan 1970 00:24

\* - Last Used Config      L - Config File is Locked

Select the bank to erase: (A, B): [A] a  
Erase SW load image from bank A.

Operation completed successfully.

**Boot config>list**

BankA	Description	Date
IMAGE - NONE		01 Jan 1970
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:26
CONFIG 2 - AVAIL *	test config for pubs	01 Jan 1970 01:13
CONFIG 3 - AVAIL		01 Jan 1970 00:58
CONFIG 4 - AVAIL		01 Jan 1970 00:39

BankB	Description	Date
IMAGE - ACTIVE		01 Jan 1970
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:54
CONFIG 2 - AVAIL		01 Jan 1970 00:01
CONFIG 3 - AVAIL		01 Jan 1970 00:14
CONFIG 4 - ACTIVE *		01 Jan 1970 00:24

\* - Last Used Config      L - Config File is Locked

Auto-boot mode is enabled. Fast-boot mode is disabled.

**Example: Boot config>erase configuration**

BankA	Description	Date
IMAGE - NONE		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:26
CONFIG 2 - AVAIL *	test config for pubs	01 Jan 1970 01:13
CONFIG 3 - AVAIL		01 Jan 1970 01:26
CONFIG 4 - AVAIL		01 Jan 1970 01:39

BankB	Description	Date
IMAGE - ACTIVE		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:54
CONFIG 2 - AVAIL		01 Jan 1970 00:01
CONFIG 3 - AVAIL		01 Jan 1970 00:14
CONFIG 4 - ACTIVE *		01 Jan 1970 00:24

\* - Last Used Config      L - Config File is Locked

Select the source bank: (A, B): [A]  
Select the configuration to erase: (1, 2, 3, 4): [1] 3  
Erase SW configuration file from bank A, configuration 3.

Operation completed successfully.

**Boot config>list**

BankA	Description	Date
IMAGE - NONE		
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:14
CONFIG 2 - AVAIL *	test config for pubs	01 Jan 1970 01:13
CONFIG 3 - NONE		01 Jan 1970 00:58
CONFIG 4 - AVAIL		01 Jan 1970 00:26

BankB	Description	Date
IMAGE - ACTIVE		01 Jan 1970
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:54

```

| CONFIG 2 - AVAIL          |          | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL          |          | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *      |          | 01 Jan 1970 00:24 |

```

```

+-----+-----+-----+
* - Last Used Config      L - Config File is Locked

```

Auto-boot mode is enabled. Fast-boot mode is disabled.

Notice that the list command displays **NONE** by bank A, config 3.

If the erasure fails, a message indicating the failure appears on the console with the banks that failed.

## List

Use the **list** command to display information about which load images and configuration files are available and active. This command may also be used to display boot options and scheduled load information.

### Syntax:

**list**

**Example:** Boot config>list

```

+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - AVAIL          |          | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL      | test config for pubs | 01 Jan 1970 01:26 |
| CONFIG 2 - AVAIL *    | test config for pubs | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE       |          | 01 Jan 1970 00:58 |
| CONFIG 4 - AVAIL      |          | 01 Jan 1970 00:39 |

```

```

+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE        |          | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL      | test config for pubs | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL      |          | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL      |          | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *   |          | 01 Jan 1970 00:24 |

```

```

+-----+-----+-----+
* - Last Used Config      L - Config File is Locked
Auto-boot mode is enabled. Fast-boot mode is disabled.

```

Time Activated Load Schedule Information...

The device is scheduled to reload as follows.

```

Date: June 26, 1997
Time: 16:30
The load modules are in bank A.
The configuration is CONFIG 1 in bank A.
Boot config>

```

The possible file status descriptors are:

### ACTIVE

The file is currently loaded and is running on the 2216

**AVAIL** This is a valid file that can be made ACTIVE.

### CORRUPT

The file was damaged or not loaded into the 2216 completely. The file must be replaced.

### LOCAL

The file will be used only on the next reload or reset. After the file is used, it will be placed in AVAIL state.

## PENDING

This file will be loaded on the next reload, reset, or power-up of the 2216.

## Lock

Use the **lock** command to prevent the device from overwriting the selected configuration with any other configuration.

### Syntax:

#### lock

**Example:** Boot config>**lock**

```
+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE                |                               | 01 Jan 1970 01:03 |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:26 |
| CONFIG 2 - AVAIL *          | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE             |                               | 01 Jan 1970 00:58 |
| CONFIG 4 - AVAIL            |                               | 01 Jan 1970 00:26 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE              |                               | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL            |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL            |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *         |                               | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked
```

Auto-boot mode is enabled. Select the source bank: (A, B): [A]

Select the source configuration: (1, 2, 3, 4): [1] 4  
Attempting to lock bank A and configuration 4.

Operation completed successfully.

Boot config>**list**

```
+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE                |                               | 01 Jan 1970       |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:13 |
| CONFIG 2 - AVAIL *          | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE             |                               | 01 Jan 1970 00:58 |
| CONFIG 4 - AVAIL L          |                               | 01 Jan 1970 00:26 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE              |                               | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL            |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL            |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *         |                               | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked
```

Auto-boot mode is enabled. Fast-boot mode is disabled.

**Note:** Note that bank A config 4 is marked with an "L."

## Set

Use the **set** command to select the code bank, the configuration to use, and the duration of use. The valid durations are:

**once** The configuration is active for the next boot only.

#### **always**

The configuration is active for all subsequent boots until changed again.

### Syntax:

## set

**Example:** Boot config>set

```
+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE                |                               | 01 Jan 1970 01:03 |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:13 |
| CONFIG 2 - AVAIL *          | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE             |                               | 01 Jan 1970 00:58 |
| CONFIG 4 - AVAIL            |                               | 01 Jan 1970 00:26 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE              |                               | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL            |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL            |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *         |                               | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked
```

Select the source bank: (A, B): [A] b

Select the source configuration: (1, 2, 3, 4): [1] 4

Select the duration to use for booting: (once, always): [always]

Set SW to boot using bank B and configuration 4, always.

Operation completed successfully.

Boot config>list

```
+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE                |                               | 01 Jan 1970       |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:13 |
| CONFIG 2 - AVAIL *          | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE             |                               | 01 Jan 1970 00:58 |
| CONFIG 4 - AVAIL            |                               | 01 Jan 1970 00:26 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE              |                               | 01 Jan 1970       |
| CONFIG 1 - AVAIL            | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL            |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL            |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *         |                               | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked
```

Auto-boot mode is enabled. Fast-boot mode is disabled.

## TFTP

Use the **tftp** command to initiate TFTP file transfers between the 2216 and remote servers.

**Note:** When you unzip an image, you will see multiple files ending in “.ld”. Use the **tftp get load modules** command to get multiple load modules.

**Syntax:**

```
tftp get                config
                        load modules

tftp put                config
                        load single image
                        load modules
```

**Example:** Boot config>tftp get load single

```

+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE                |                               | 01 Jan 1970 01:03 |
| CONFIG 1 - AVAIL           | test config for pubs         | 01 Jan 1970 00:01 |
| CONFIG 2 - AVAIL *         | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE            |                               | 01 Jan 1970 00:58 |
| CONFIG 4 - AVAIL           |                               | 01 Jan 1970 00:14 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE              |                               | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL           | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL           |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL           |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *        |                               | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked

```

```

Specify the server IP address (dotted decimal): : [1.2.3.4] 192.9.200.1
Specify the remote file name: : (/u/bin) /usr/2216load/c200-rtr.img
Select the destination bank: (A, B): [A] a
TFTP SW load image
get: /usr/2216load/c200-rtr.img
from: 192.9.200.1
to: bank A.

```

Operation completed successfully.

**Note for Dynamic Loading of Software:** All of the load modules in the specified directory will be retrieved as part of the load going into the bank. For loads for releases prior to Version 1, Release 2, this will be a single load module. For Version 1, Release 2 loads and later, this may be multiple load modules.

**Example: Boot config>tftp get load modules**

```

+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE                |                               | 01 Jan 1970 01:03 |
| CONFIG 1 - AVAIL           | test config for pubs         | 01 Jan 1970 00:01 |
| CONFIG 2 - AVAIL *         | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE            |                               | 01 Jan 1970 00:58 |
| CONFIG 4 - AVAIL           |                               | 01 Jan 1970 00:14 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE              |                               | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL           | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL           |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL           |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE *        |                               | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked

```

```

Specify the server IP address (dotted decimal): : [1.2.3.4] 192.9.200.1
Specify the remote modules directory: : (/u/bin) /usr/2216load/
Select the destination bank: (A, B): [A] a
TFTP SW load image
get: /usr/2216load/LML.ld
from: 192.9.200.1
to: bank A.

```

Operation completed successfully.

**Notes:**

When putting files to a server:

1. Make sure that the files on the target server have the appropriate permissions that would allow anyone to write to those files. If not, the put operation will fail.
2. You must be aware of the files you are putting to the target server. To determine whether the image in the bank is a single module or multiple modules, use the **describe** command. A load prior to Version 1, Release 2 is a single module. Loads at Version 1, Release 2 or after are multiple modules.



## Timedload

Use the **timedload** command to schedule a load on a device, cancel a scheduled load, or view scheduled load information.

This command allows you to load the device outside peak network traffic periods when support personnel may not be present.

**Note:** You may also use the Configuration Program to schedule a reload for a device, which is not affected by reloads or power outages. These circumstances would normally cause the reload to be lost. See the chapter “Using the Configuration Program” in *Configuration Program User’s Guide for Nways Multiprotocol and Access Services* for details.

### Syntax:

```
timedload          activate
                    deactivate
                    view
```

### activate

Schedules a load on the device. You will be prompted for information for a time-activated load similar to the **tftp get load** and **tftp get config** commands. See “TFTP” on page 57 for information about the parameters.

#### Time of day to load the router

Specifies the date and time to load the device. Specify the value as *YYYYMMDDHHMM*, where:

*YYYY* is the four-digit year

**Note:** If the current month on the device is December, the year data must be the current year or the following year. Otherwise, if the current month on the device is January through November, the year data must be the current year.

*MM* is the two digit month.

**MM Valid Values:** 01 to 12 with 01 representing January.

*DD* is the two-digit day of the month.

**DD Valid Values:** 01 to 31, depending on the value of *MM*.

*HH* is the two-digit hour in 24-hour time.

**HH Valid Values:** 00 to 23

*MM* is the two-digit minute of the hour.

**MM Valid Values:** 00 to 59

The following are examples of scheduling a load from different sources.

### Example 1. Load modules and configuration source is a remote host:

```
Boot config>timedload activate
```

	Description	Date
+----- BankA -----+		
IMAGE - AVAIL		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 01:26
CONFIG 2 - AVAIL *	test config for pubs	01 Jan 1970 01:13
CONFIG 3 - NONE		01 Jan 1970 00:58
CONFIG 4 - AVAIL		01 Jan 1970 00:39
+----- BankB -----+		
IMAGE - ACTIVE		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:54
CONFIG 2 - AVAIL		01 Jan 1970 00:01

```

| CONFIG 3 - AVAIL | | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE * | | 01 Jan 1970 00:24 |

```

```

+-----+-----+
* - Last Used Config      L - Config File is Locked

```

Time Activated Load Processing...

Select the bank to use: (A, B): [A] **a**  
Do you want to put load modules into the bank? (Yes, No, Quit): [Yes] **yes**

Do you want to retrieve a SINGLE image or a set of MODULES? [MODULES]? **modules**  
Specify the server IP address (dotted decimal): : [1.2.3.4] **192.9.200.1**  
Specify the remote modules directory: : (/u/bin) /usr/601bin/205img  
The destination bank is bank A

```

TFTP SW load image
get: /usr/601bin/205img/
from: 192.9.200.1
to: bank A.
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'
tftp: connect to '192.9.200.1'

```

Operation completed successfully.

Do you want to put a configuration into the bank? (Yes, No, Quit): [Yes] **yes**

Specify the server IP address (dotted decimal): : [1.2.3.4] **192.9.200.1**  
Specify the remote file name: : (config.dat) /tftpboot/192.9.200.6.config  
The destination bank is bank A  
Select the destination configuration: (1, 2, 3, 4): [1] **1**

```

TFTP SW configuration file
get: /tftpboot/192.9.200.6.config
from: 192.9.200.1
to: bank A, configuration 1.
tftp: connect to '192.9.200.1'

```

Operation completed successfully.

Time of day to load the router (YYYYMMDDHHMM) []? **199706261630**  
The load timer has been activated.  
Boot config>

**Example 2. Load modules and configuration source is a bank:**

Boot config>**timedload activate**

BankA	Description	Date
IMAGE - AVAIL		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 01:26
CONFIG 2 - AVAIL *	test config for pubs	01 Jan 1970 01:13
CONFIG 3 - NONE		01 Jan 1970 00:58
CONFIG 4 - AVAIL		01 Jan 1970 00:39
BankB	Description	Date
IMAGE - ACTIVE		01 Jan 1970 00:01
CONFIG 1 - AVAIL	test config for pubs	01 Jan 1970 00:54
CONFIG 2 - AVAIL		01 Jan 1970 00:01
CONFIG 3 - AVAIL		01 Jan 1970 00:14
CONFIG 4 - ACTIVE *		01 Jan 1970 00:24

```

+-----+-----+
* - Last Used Config      L - Config File is Locked

```

Time Activated Load Processing...

Select the bank to use: (A, B): [A] **a**  
Do you want to put load modules into the bank? (Yes, No, Quit): [Yes] **no**

Do you want to put a configuration into the bank? (Yes, No, Quit): [Yes] **no**

Select the configuration to use: (1, 2, 3, 4): [1] **1**

Time of day to load the router (YYYYMMDDHHMM) []? **199706261630**  
The load timer has been activated.  
Boot config>

## deactivate

Cancels a scheduled load.

### Example 1: Deactivate the time activated load

```
Boot config>timedload deactivate
Deactivate Load Timer Processing...
```

```
Do you want to deactivate the load timer? (Yes, No, Quit): [No] yes
The load timer has been deactivated.
Boot config>
```

**view** Displays scheduled load information.

```
Boot Config> timedload view
Time Activated Load Schedule Information...
```

The router is scheduled to reload as follows.

```
Date: June 26, 1997
Time: 16:30
The load modules are in bank A.
The configuration is CONFIG 1 in bank A.
Boot config>
```

## Unlock

Use the **unlock** command to allow the device to overwrite the selected configuration that was previously locked.

### Syntax:

#### unlock

#### Example: Boot config>unlock

```
+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE          |                               | 01 Jan 1970 01:03 |
| CONFIG 1 - AVAIL     | test config for pubs         | 01 Jan 1970 00:13 |
| CONFIG 2 - AVAIL     | * test config for pubs       | 01 Jan 1970 01:13 |
| CONFIG 3 - NONE      |                               | 01 Jan 1970 00:58 |
| CONFIG 4 - AVAIL     | L                             | 01 Jan 1970 00:26 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE       |                               | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL     | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL     |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL     |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE    | *                             | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked
```

Select the source bank: (A, B): [A]

Select the source configuration: (1, 2, 3, 4): [1] 4  
Attempting to unlock bank A and configuration 4.

Operation completed successfully.

```
Boot config>list
```

```
+----- BankA -----+----- Description -----+----- Date -----+
| IMAGE - NONE          |                               | 01 Jan 1970 00:01 |
| CONFIG 1 - AVAIL     | test config for pubs         | 01 Jan 1970 01:13 |
| CONFIG 2 - AVAIL     | * test config for pubs       | 01 Jan 1970 00:58 |
| CONFIG 3 - NONE      |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - AVAIL     |                               | 01 Jan 1970 00:14 |
+----- BankB -----+----- Description -----+----- Date -----+
| IMAGE - ACTIVE       |                               | 01 Jan 1970      |
| CONFIG 1 - AVAIL     | test config for pubs         | 01 Jan 1970 00:54 |
| CONFIG 2 - AVAIL     |                               | 01 Jan 1970 00:01 |
| CONFIG 3 - AVAIL     |                               | 01 Jan 1970 00:14 |
| CONFIG 4 - ACTIVE    | *                             | 01 Jan 1970 00:24 |
+-----+-----+-----+
* - Last Used Config      L - Config File is Locked
```

Auto-boot mode is enabled. Fast-boot mode is disabled.

**Note:** Note that bank A config 4 is no longer marked with an “L.”

## Update-firmware

Use the **update-firmware** command to install the Firm.ld load module that you have received on either Bank A or Bank B of your 2216.

Rebooting will not occur automatically after this command is executed. You must set the bank you want to reboot from using the Boot config> set command, and the new firmware will be updated when you reboot. See “Chapter 3. Accessing the Firmware from the Command Line Interface” on page 29 for rebooting information.

### Syntax:

#### update-firmware

### Example:

```
Boot config>update
```

BANK A		BANK B	
Product ID -	2216-MAS	Product ID -	2216-MAS
Version 3 Release	1	Version 3 Release	1
Mod 0 PTF	0	Mod 0 PTF	0
Feat. 2807 RPQ	0	Feat. 2807 RPQ	0
Date 14 Jul 1998 07:45		Date 7 Aug 1998 14:05	
Build cc_155b		Build cc_158b	
		test-load	

DO NOT POWER OFF while firmware is updating.  
To exit, type Ctrl-c at the Select bank/restore prompt.

Select the source bank or P to restore from Precover.img: (A, B, P): [A]B

```
Using Local Firmware image /hd0/sys1/Firm.ld
flash: ID = 0x01A4, sector wp = 0x00
flash: Found /hd0/sys1/Firm.ld:524774 bytes.
flash: Loading file /hd0/sys1/Firm.ld...
flash: File /hd0/sys1/Firm.ld loaded at 0x0025f0ec for 524288 bytes
flash: Creating /hd0/precover.img from flash
flash: Recovery image created.
flash: Validating firmware image
flash: Update from:0025F0EC, offset=00010000, flash size=524288
flash: Erasing sector 7f
flash: Erasing sector 3f
flash: Erasing sector 1f
flash: Erasing sector f
flash: Erasing sector 7
flash: Erasing sector 3
flash: Erasing sector 1
flash: Current addr = 0007f000
```

Operation completed successfully.

---

## Chapter 7. The CONFIG Process (CONFIG - Talk 6) and Commands

This chapter describes the CONFIG process configuration and operational commands. It includes the following sections:

- “What is CONFIG?”
- “Entering and Exiting CONFIG” on page 71
- “CONFIG Commands” on page 71

---

### What is CONFIG?

The Configuration process (CONFIG) is a second-level process of the device user interface. Using CONFIG commands, you can:

- Set or change various configuration parameters
- Add or delete an interface to the hardware configuration
- Enter the Boot CONFIG command mode
- Enter the Quick Configuration mode
- Clear, list, or update configuration information
- Enable or disable console login
- Communicate with third-level processes, including protocol environments

**Note:** Refer to the chapter “Migrating to a New Code Level” in *2216 Nways Multiaccess Connector Service and Maintenance Manual* for information about migrating to a new code level.

CONFIG lets you display or change the configuration information stored in the device’s nonvolatile configuration memory. Changes to system and protocol parameters do not take effect until you reload the device software. (For more information, refer to the OPCON **reload** command in “What is the OPCON Process?” on page 31).

**Note:** You must enter the **write** command to save the changes in the device’s flash memory.

The CONFIG command interface is made up of levels that are called modes. Each mode has its own prompt. For example, the prompt for the SNMP protocol is `SNMP config>`.

If you want to know the process and mode you are communicating with, press **Enter** to display the prompt. Some commands in this chapter, such as the **network** and **protocol** commands, allow you to access and exit the various levels in CONFIG. See Table 7 on page 72 for a list of the commands you can issue from the CONFIG process.

### Config-Only Mode

Config-Only mode is entered if the configuration file that you are using is empty or no protocols are configured. Config-Only mode can also be entered manually to recover from an invalid configuration that is causing the router to crash during start-up.

#### Automatic Entry Into Config-Only Mode

Config-Only mode is entered if the router is booting with an empty configuration file or the configuration file contains incomplete configuration data.

## Using the CONFIG Process

The following conditions cause the router to enter Config-Only mode:

- Devices are configured but no protocols are configured.
- Deletion of all router interface information.
- The configuration file is empty.

### Manual Entry Into Config-Only Mode

To enter Config-Only mode, do one of the following:

- Reload the router with no configuration.

To reload the router with no configuration, use the **erase** change management configuration command. Then use the **set** change management configuration command to select the empty configuration file. You can access change management configuration commands from the Boot> prompt.

- Reload the router with no interfaces configured.
- Reload the router with no protocols configured.

To create a configuration that has no protocols configured, use the **clear** command to clear the protocol configuration information.

**Note:** If autoboot is enabled and you press **Ctrl-C** while the software is loading, you go directly to the bootstrap monitor > prompt without seeing the text and you can skip step 1. Otherwise, the following text appears:

```
PROM Load/Dump Program * Revision: 1.15 *
Copyright IBM Corp. 1994, 1997
Host **VL-51* loading
Using Ethernet at ( 81600, 94).
Trying host 128.185.210.125, via 128.185.123.28
      file loads/latest-gen.rbx2-multisna.ldc
-loading
.....
....
```

1. If boot information is missing, the software will load from the IBD. If the first IBD file is invalid, such as a config file, the software will go to the manual load prompt:

```
No valid boot records found, attempting IBD load
Loading using IBD Load Image "v12-15.cfg"
Bad record header 0

No valid server configured -- Entering manual mode
Device types available:

      IBD
      Token Ring
      WAN
```

Device type:

2. Press **Ctrl-C** to go to the bootstrap monitor. The > prompt displays.
3. Boot to Config-Only mode.

```
>bc

PROM Load/Dump Program * Revision: 1.15 *
Copyright IBM Corp. 1994, 1997
Host **VL-51* loading

Device types available:

      IBD
      Ethernet
      WAN

Device type [Ethernet]:
Connector Type (AUI/RJ45) [AUTO_CONFIG]:
Interface IP address [128.185.123.51]: 10.1.155.22
IP mask [FFFFFF00]:
Boot from host [128.185.210.125]:
Via gateway [128.185.123.28]: 43
Boot file name [loads/latest-gen.rbx2-multisna.ldc]:

Using Ethernet at (      0, 0).
Trying host 128.185.210.125, via 128.185.123.28
      file loads/latest-gen.rbx2-multisna.ldc
```

```

·loading
·.....
Starting at 1040010

The Standalone Configuration Process. You are here because
The watchdog timer timed out and/or Autoboot not selected

Config (only)>

```

Otherwise, the router will reboot. If boot information is missing, the software will load from the hard drive.

See “Chapter 3. Accessing the Firmware from the Command Line Interface” on page 29 for more information.

## Quick Configuration

Quick Configuration (Quick Config) provides a minimal set of commands that allow you to configure bridging protocols and routing protocols present in the device load. You can also configure an SNMP community with WRITE\_READ\_TRAP access. This is useful during initial setup because the configuration program uses SNMP SET commands to transfer the configuration.

**Important:** At least one network device must be configured before using quick config. To add a device, use the **add device** command at the `config(only)>` or `config>` prompt. See “Accessing the Network Interface Configuration Process” on page 15 for more information.

The following table lists the protocols supported by Quick Config.

*Table 6. Quick Config Capabilities*

ATM Protocols	Bridging Protocols	Routing Protocols
LAN Emulation	STB, SRT, SRB	IP, IPX, DNA IV

Quick Config complements the existing configuration process by offering a shortcut. This shortcut allows you to configure the minimum number of parameters for these bridging protocols and routing protocols without having to exit and enter the different configuration processes. The other parameters are set to selected defaults.

Situations that call for the device to be quickly configured are:

- Blank or corrupted configuration memory, such as when one of the following situations occurs:
  - The device is configured for the first time.
  - Voltage fluctuations caused corruption of the hard file.
- Demonstration purposes, for which the device needs to be quickly configured to demonstrate its capabilities.
- Bench-marking tests to get the tests going without having to learn the device’s operating system commands.

Quick Config operates as follows:

- It asks a series of questions with default values.
- It offers a short-cut to the detailed configuration of the normal mode command set.

Quick Config sets a number of default parameters based upon how you answer the configuration questions. What cannot be configured with Quick Config can be configured using Config after exiting Quick Config.

## Using the CONFIG Process

You cannot delete Quick Config information from within Quick Config. However, you can correct information either by exiting and returning to Quick Config, or by entering the **reload** command as a response to some Quick Config questions.

For complete information on using the Quick Config software, see “Appendix A. Quick Configuration Reference” on page 755.

### Manual Entry Into Quick Config Mode

You might want to run Quick Config manually to demonstrate the device’s capabilities or to reconfigure dynamically to perform benchmark tests without having to learn the device’s operating system commands.

To enter Quick Config, type **qconfig** at the `Config>` prompt.

### Exiting from Quick Config Mode

To exit Quick Config, restart by entering **r** from any prompt. Follow the queries until you enter **no** and then enter **q** to quit. The router returns to either the `Config (only)>` or the `Config>` prompt.

## Configuring User Access

The device configuration process allows for a maximum of 50 user names, passwords, and levels of permission. Each user needs to be assigned a password and level of permission. There are three levels of permission: *Administration*, *Operation*, and *Monitoring*.

For more information, see on page 78.

### Technical Support Access

If you are the system administrator, when you add a new user for the first time, you are asked if you want to add Technical Support access. If you answer yes, Technical Support is granted the same access privileges that you have as system administrator.

The password for this account is automatically selected by the software and is known by your service representative. This password can be changed using the **change user** command; however, if you do change the password, customer service cannot provide remote support. For additional information on the use of the **change user** command, see “Change” on page 79.

## Configuring Spare Interfaces

Occasionally, you may need to configure a new interface along with its bridging and routing protocols without having to restart the device. You can accomplish this by configuring a number of **spare interfaces** on your device. Spare interfaces are useful if:

- You are “hot-plugging” a new adapter into your device.  
You can install the adapter, configure it and then activate it without unplugging or restarting the device.
- You are adding dial circuits to your device.  
Use spare interfaces to add new V.25 bis or ISDN dial circuits on an existing V.25 bis or ISDN interface.

**Note:** You cannot add spare interfaces to channelized ISDN T1/E1 interfaces.

- You are adding ATM LAN Emulation clients.



## Using the CONFIG Process

Use spare interfaces to add Token-Ring or Ethernet ATM LAN Emulation clients to an existing ATM interface.

- You are adding virtual networks to an existing ESCON Channel Adapter or Parallel Channel Adapter.

To configure a spare interface:

1. Access the CONFIG process by entering **configuration**.
2. Configure the number of spare interfaces for the device using the **set spare-interfaces** command.
3. Exit the CONFIG process by pressing **Ctrl-P**.
4. Reload the device.

### Example:

```
* configuration
Config> set spare 2
Config>
*reload
Are you sure you want to reload the gateway? (Yes or [No]) yes
```

When the device reloads, the spare interfaces are installed as null devices.

To use one of the spare interfaces:

1. Insert the new adapter into the adapter slot.

**Note:** If you are using an ESCON or Parallel channel adapter, you have the ability to define spare interfaces for each of the attached networks without using additional adapters. In this case, you can bypass this step.

2. Access the CONFIG process by entering **configuration**.
3. Add an interface or a dial circuit using the **add device** command, if necessary.
4. Configure the spare interface by using the **net** command to configure the interface or add ATM LAN Emulation clients.
5. Configure the various protocols and features using the **protocol** and **feature** commands.
6. Exit the CONFIG process by pressing **Ctrl-P**.
7. Access the GWCON process by entering **console**.
8. Bring the new interface online to the network using the **activate** command.

The following example shows how to configure and activate a new dial circuit on which the IP protocol is enabled. The dial circuit and IP protocol configuration are not shown.

### Example:

```
*configuration
Config> add device dial-circuit
Config> net 6
Circuit configuration
Circuit config>
:
Here you would configure the dial circuit
:
Circuit config> exit
Config> protocol ip
IP>
```

## Using the CONFIG Process

```
:
  Here you would configure the IP protocol on the dial circuit.
:
IP> exit
Config>
*console
+activate 6
```

The following example shows how to configure and activate a new ATM LAN Emulation Client on which the IP protocol is configured. The ATM LAN Emulation Client and IP configurations are not shown.

```
* configuration
Config> net 0
ATM User Configuration
ATM Config> le-client
ATM LAN Emulation Clients Configuration
LE Client config> add token-ring
Added Emulated LAN as interface 6
LE Client config> config 6
ATM LAN Emulation Client configuration
:
(Here you would configure the ATM LAN Emulation Client)
:
Token Ring Forum Compliant LEC Config> exit
LE Client config> exit
ATM Config> exit
Config> protocol ip
IP Config>
:
(Here you would configure IP on the ATM LAN Emulation Client)
:
IP Config> exit
Config> write
ctrl-p
* console
+ activate 6
Interface 6 activated successfully
```

## Restrictions for Spare Interfaces

The **activate** command cannot be used to activate a new interface on the network under the following conditions:

- You have already entered a **delete interface** command. The device must be restarted if **any** interface has been deleted. You cannot delete a spare interface (indicated by **null** in list displays).
- The spare interface is the only interface that enables a protocol or feature. The protocol or feature must already be enabled on an existing interface before it can be used by a spare interface.
- The new spare interface has a header size or trailer size greater than the sizes for other interfaces.
- There is not enough memory to allocate receive buffers for the new interface.

In these cases, you must restart the device to bring the new interface online.

The **activate** command does not activate all spare interfaces. To determine how the **activate** command affects spare interfaces, see the section on dynamic reconfiguration that is included in the configuring and monitoring chapter for each interface

## Using the CONFIG Process

A couple of spare interfaces do not include dynamic reconfiguration information in their descriptions and cannot be activated on the network using the **activate** command. These interfaces are included in the following list:

- SDLC
- V.25 bis

You must restart the device to bring these interfaces online.

You can configure the following protocol on spare interfaces, but you cannot activate it on the network using the **activate** command:

- OSI/DECnet V

**Note:** When using the configuration program, use the following to work with spare interfaces:

1. Make the configuration changes for the spare interface on the device
2. Enter the **activate** command on the device to bring the spare interface, protocols, and features online
3. Retrieve the configuration using the configuration program
4. Save the retrieved configuration into the configuration program database

Certain functions have requirements for the **activate** command. For most of the affected functions, these requirements are described in the configuring and monitoring chapter for each function. In the applicable chapter, see the section about dynamic reconfiguration.

For functions not described in the configuring and monitoring chapters, these are the requirements of the **activate** command:

DECnet IV      To activate this protocol on a spare interface, you must first activate the interface and then configure the protocol on the activated interface. Use the DECnet IV **set** command to activate the configuration changes.

## Resetting Interfaces

Occasionally, you might need to change the configuration of a network interface along with its bridging and routing protocols without restarting the device. The **reset** command allows you to disable a network interface and then enable it using new interface, bridging and routing configuration parameters.

The interface, protocols and features configuration parameters are changed using the CONFIG process (talk 6) commands. The talk 6 commands affect the contents of the configuration memory. The configuration changes are activated by issuing the GWCON process (talk 5) **reset** command.

To reset an interface:

1. Access the CONFIG process (talk 6).
2. Use the **net** command and other commands to change configuration parameters.
3. Use the **protocol** and **feature** commands to change the interface-based configuration parameters.
4. Exit the CONFIG process by pressing **Ctrl-P**.
5. Access the GWCON process (talk 5).
6. Use the **reset** command to reset the interface and the protocols and features on the interface.

## Using the CONFIG Process

### Example:

```
* configuration
Config>net 1
PPP Config>

. . . change PPP parameters . . .

PPP Config>exit
Config>protocol ipx
IPX Config>

. . . change IPX parameters on the PPP interface . . .

IPX Config>exit
Config>
*talk 5
+reset 1
Resetting net 1 PPP/0...successful
```

**Note:** When using the configuration program, do the following to make configuration changes to existing interfaces:

1. Make the configuration changes for the interface on the device
2. Enter the **reset** command to reset interface, protocol and feature parameters
3. Retrieve the configuration using the configuration program
4. Save the retrieved configuration into the configuration program database

### Restrictions for Resetting Interfaces

The **reset** command cannot be used to reset a network interface if:

- You have already entered a **delete interface** command. The device must be reloaded if any interface has been deleted.
- You have changed the hardware or data link type. For example, changing the data link type from PPP to Frame Relay.
- You have configured a larger MTU.
- You have configured a routing protocol or bridging on the interface, but that routing protocol or bridging is not currently active in the device.

In these situations, you must reload the device to activate the configuration changes.

Configured changes for certain interfaces, features, and protocols cannot be activated using the **reset** command. For most of these interfaces, features, and protocols, the use of the **reset** command is described in the section about dynamic reconfiguration in the configuring and monitoring chapter.

The V.25 bis interface cannot be activated using the **reset** command and the **reset** command for this interface is not described in the configuring and monitoring chapter.

You must reload the device to activate the configuration changes.

The following list includes the protocols and features that cannot be activated using the **reset** command and for which the **reset** command is not described in the configuring and monitoring chapter.

- AppleTalk
- Vines
- OSI/DECnet V

There are also requirements associated with **reset** for certain functions that are not described in the configuring and monitoring chapters. These requirements are listed by function in the following table:

Compression	Compression requires large header and trailer sizes. Unless compression is already enabled on some other interface, it is likely that the header and trailer sizes will be too small. In this case, compression is disabled automatically on the interface and an ELS message is logged (rather than causing the entire reset interface to fail).
DNA IV	Use the DNA IV <b>set</b> command to activate configuration changes.

## Using System Dumps

A useful tool for debugging problems with the 2216 is the system dump. The dump is a compressed snapshot that the system saves to the hard drive if one is present, or to a remote host on the network .

To configure dumping:

1. Specify which three dump files you will save. See page 101 for more information.
2. Specify whether you want dumping re-enabled after a dump occurs. See page 101 for more information.
3. Enable dumping on the 2216. See page 89 for more information.

You can view the status of system dumping or retrieve a dump from the system. See “System View” on page 105 and “System Retrieve” on page 105, respectively.

---

## Entering and Exiting CONFIG

To enter the CONFIG process from OPCON and obtain the CONFIG prompt, enter the **configuration** command. Alternatively, you can enter the OPCON **talk** command and the PID for CONFIG. The PID for CONFIG is 6.

```
* configuration
```

or

```
* talk 6
```

The console displays the CONFIG prompt (Config>). If the prompt does not appear, press the **Enter** key again.

To exit CONFIG and return to the OPCON prompt (\*), enter the intercept character. (The default is **Ctrl-P** .)

---

## CONFIG Commands

This section describes each of the CONFIG commands. Each command includes a description, syntax requirements, and an example. The CONFIG commands are summarized in Table 7 on page 72.

After accessing the CONFIG environment, enter the configuration commands at the Config> prompt.

## CONFIG Commands

Table 7. CONFIG Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Add	Adds an interface to the device configuration, or a user to the device.
Boot	Enters Boot CONFIG command mode.
Change	Changes a user's password, or a user's parameter values associated with this interface. Also changes a slot/port of an interface.
Clear	Clears configuration information.
Delete	Deletes an interface from the router configuration or deletes a configured user. Also deletes system dump files.
Disable	Disables command completion, login from a remote console, disables modem use
Enable	Enables command completion, login from a remote console, enables modem use
Event	Enters the Event Logging System configuration environment.
Feature	Provides access to configuration commands for independent device features outside the usual protocol and network interface configuration processes.
List	Displays system parameters, hardware configuration, a complete user list.
Load	Lists, adds, or deletes optional software packages.
Network	Enters the configuration environment of the specified network.
Patch	Modifies the device's global configuration.
Performance	Provides a snapshot of the main processor utilization statistics.
Protocol	Enters the command environment of the specified protocol.
Qconfig	Initiates the Quick Config process.
Set	Sets system-wide parameters for buffers, host name, inactivity timer, packet size, prompt level, number of spare interfaces, dump parameters, location, and contact person.
System Retrieve	Retrieves dumps
System View	Displays the dump settings and the current dump status. Also displays a summary of the dumps.
Time	Keeps track of system time and displays it on the console.
Unpatch	Restores patch variables to default values.
Update	Updates the configuration memory when you receive a new software load.
Write	Writes the current configuration information to the nonvolatile memory.

## Add

Use the **add** command to add an interface to the configuration, or user-access. This command also recreates device records if the configuration is inadvertently lost.

### Syntax:

```
add                callback . . .
                   device
                   isdn-address . . .
                   ppp-user
                   tunnel-profile
                   user . . .
                   v25-bis-address
```

**callback**

Use the **add callback** command to add, delete, or list information for callback on ISDN.

- Add** Adds a callback number to the authentication lists.
- Delete** Deletes a callback number from the authentication list.
- Lists** Displays the authentication list and other related information.

**device** *device\_type additional-config-info*

With the **add device** command, you must enter the interface device type (*device\_type*). You are prompted for additional configuration parameters. This additional information varies by device and platform. Refer to “Adding Devices” on page 15 for additional information about device type and configuration parameters.

**Note:** If you are adding more than one interface, the order in which you add them is important because the device assigns a sequential interface number to the device when it is added. This interface number is an index number in the device list; it links the device with other protocol configuration information, such as the IP addresses associated with the device. (For more information, refer to the **list devices** command, “List” on page 91.)

All device and protocol configuration information related to network interfaces is stored by interface number. Any changes made to interface numbers will invalidate much of the device configuration information in the protocols.

**Example:**

```
add device atm
Device Slot #(1-8) [1]? 2
Adding CHARM ATM Adapter device in slot 2 port 1 as interface x
(where x is the interface number assigned)
```

To determine which devices you can add, use the **add devices ?** command.

**isdn-address** *address-name network-dial-address network-subdial-address*

Adds the local and remote numbers of the ISDN end-points that will be communicating with your router.

**address-name**

Can be anything (such as a description of the port).

**network-dial-address**

The telephone number of the local or the destination port.

**network-subdial-address**

The additional part of the telephone number, such as an extension, that gets interpreted when the interface connects to a PBX; this parameter is optional.

**Note:** You can use punctuation, such as parentheses and dashes, but the punctuation is not significant (the router uses only the numbers).

```
Example: add isdn-address line 1 local
Assign network dial address [0 - 32 digits]? 1 2345 67
Assign network subdial address [0 - 19 digits]? 98765
```

## CONFIG Commands

### ppp-user

Adds the user profile of a remote user to the local PPP user data base. You can add up to 500 users. You add a PPP user for each remote router or DIALs client that can connect to the device you are configuring. You must configure PPP users if either of the following conditions exist:

- You are using PPP authentication protocols, PPP encryption, or allowing users to use the dial-out feature. You need to configure a PPP user for either type of encryption - Encryption Control Protocol (ECP) or Microsoft Point-to-Point Encryption (MPPE); however, MPPE does not require the encryption key.
- You want the PPP user data base to be locally stored and managed by the device. If you want PPP user information to be obtained from a RADIUS, TACACS, or TACACS+ server, then you should configure the Authentication feature instead of configuring local PPP users.

**Note:** MPPE cannot use the RADIUS, TACACS, or TACACS+ server. For MPPE, the PPP user data base must be local.

If ECP has been enabled for the user, you are prompted for the PPP user name, password, IP address, and encryption key .

If the DIALs feature is in the software load, you are asked if this is a DIALs user.

If you are adding a user for a DIALs client, then you are prompted for the hostname, type of route, network mask, connect time, and call-back information.

See “Using a Dial-In Access to LANs (DIALs) Server” in the *Using and Configuring Features* for more information.

A user profile stored locally on the device consists of the following:

**Name** The userid of the PPP user, used during authentication. See “PPP Authentication Protocols” on page 587.

#### **Password**

The password known to the user and the device, used during authentication. It can be up to 31 characters in length, consist of any alphanumeric character, and is case sensitive. See “PPP Authentication Protocols” on page 587 for more information.

#### **Enter again to verify**

Enter the password again for verification.

#### **Allow inbound access**

Allows inbound access to this user profile.

**Valid values:** yes, no

**Default value:** no

#### **Will user be tunneled?**

Specifies whether this dial-in user should be tunneled to an LNS destination. If you enter “yes”, you are prompted for information about the LNS.

**Valid values:** yes, no

**Default value:** no



### **Number of days before account expiry**

The number of days before the account expires.

**Valid values:** 0 to 360

**Default value:** 180

### **Number of grace logins allowed**

The number of login attempts allowed after the password expires.

**Valid values:** 0 to 100

**Default value:** 0

### **Hostname to use when connecting to this peer:**

Specifies the local hostname of this LAC that is passed as identification to the LNS during tunnel setup.

### **Tunnel Server endpoint:**

Specifies the IP address of the LNS to which this user is tunneled.

### **Type of Route**

Either "Host Route" or "Net Route."

A host route is generally applied for single-user access. A net route is generally applied to a network access. A net route allows you to enter a net mask.

### **IP Address**

IP address to be assigned to a user.

A user profile-based IP address to offer to a dial-in client if requested. There are a number of ways for a 2216 to obtain an IP address for a dial-in client. See "IP Control Protocol" on page 593 for more information.

**Valid values:** any valid IP address

**Default value:** none

### **Net-Route Mask**

Mask for a network user.

If the dial-in user is connecting to a DIALs-enabled PPP interface, the router automatically adds a temporary static route to that client for the duration of the PPP session. Typically, this static route has a net mask of 255.255.255.255 (the default value), which implies that there is a single IP host at the other end of the PPP link. However, the net mask can be overridden. If configured, this mask is used when adding the temporary route. An example of this is a small router with a single network of hosts that dials into a DIALs-enabled router. The single route to the small office router will be installed automatically based on the user profile, making it unnecessary to configure routing protocols between the two hosts and cutting down on routing traffic overhead over a potentially slow link.

### **Hostname**

Hostname to be sent to the Proxy DHCP server for use by Dynamic DNS. See "Using a Dial-In Access to LANs (DIALs) Server" in *Using and Configuring Features* for more information.

### **Time-Allotted**

The length of time a DIALs user can be connected. This is the total for this session, and should not be confused with an inactivity timer.

## CONFIG Commands

**Valid Values:** 0 to 71 827 788 minutes (0=unlimited)

**Default Value:** 0

### Callback type

Call-back method, either “Roaming” or “Required.” The call-back parameters are used to specify whether the router will call back the user and what number to call back. See “Configuring PPP Callback” on page 590 for additional information.

### Set encryption key

Specifies whether ECP encryption is to be enabled for this user/port.

**Valid values:** yes, no

**Default value:** no

### ECP encryption key

Enter 16-character ECP encryption key.

This parameter is displayed only if PPP Encryption Control Protocol (ECP) has been enabled using the talk 6 PPP Config> **enable ecp** command. MPPE does not require an encryption key. This ECP encryption key is used by the PPP Encryption Control Protocol (ECP). See “Using and Configuring Encryption Protocols” in *Using and Configuring Features*.

### Disable user

Allows you to disable a user-profile.

**Valid values:** yes, no

**Default value:** no

### Example:

```
Config> add ppp-user
Enter name: [ ]? pppusr01
Password:
Enter again to verify:
Allow inbound access for user? (Yes, No): [yes]
Will user be tunneled? (Yes, No): [No]
Number of days before account expiry[0-1000] [0]? 10
Number of grace logins allowed after an expiry[0-100] [0]? 5
IP address: [0.0.0.0]? 1.1.1.1
Set ECP encryption key for this user? (Yes, No): [No] no
Disable user ? (Yes, No): [No]
```

```
      PPP user name: pppusr01
      User IP address: 1.1.1.1
      Virtual Conn: disabled
      Encryption: disabled
      Status: enabled
      Login Attempts: 0
      Login Failures: 0
      Lockout Attempts: 0
      Account expires: Sun 17Feb2036 06:28:16
      Account duration: 10 days 00.00.00
      Password Expiry: <unlimited>
```

User 'pppusr01' has been added

### Example:

```
Config> add ppp-user
Enter name: [ ]? tunusr01
Password:
Enter again to verify:
Allow inbound access for user? (Yes, No): [yes]
Will user be tunneled? (Yes, No): [No] yes
Enter hostname to use when connection to this peer: []? host01
Tunnel-Server endpoint address: [0.0.0.0]? 1.1.1.1
```

```
--more--          PPP user name: tunusr01
--more--          Endpoint: 1.1.1.1
--more--          Hostname: host01
```

User 'tunusr01' has been added

**Example with ECP encryption:**

```
Config>add ppp-user
Enter name: [ ]? ppp_user2
Password:
Enter again to verify:
Allow inbound access for user? (Yes, No): [Yes]
Will user be tunneled? (Yes, No): [No]
Is this a 'DIALS' user? (Yes, No): [Yes]
Type of route? (hostroute, netroute): [hostroute]
Number of days before account expiry[0-1000] [0]?
Number of grace logins allowed after an expiry[0-100] [0]?
IP address: [11.0.0.185]?
Allow virtual connections? (Yes, No): [No]
Give user default time allotted ? (Yes, No): [Yes]
Enable callback for user? (Yes, No): [No]
Will user be able to dial-out ? (Yes, No): [No]
Set ECP encryption key for this user? (Yes, No): [No] y
Encryption key should be 16 characters long.
Encryption Key (16 characters ) in Hex(0-9, a-f, A-F):
Encryption Key again (16 characters) in Hex(0-9, a-f, A-F):
ECP encryption key is set.
Disable user ? (Yes, No): [No]
```

```
      PPP user name: ppp_user2
      User IP address: 11.0.0.185
      Netroute Mask: 255.255.255.255
      Hostname:          Virtual Conn: disabled
      Time allotted: Box Default
      Callback type: disabled
      Dial-out: disabled
      Encryption: enabled
      Status: enabled
      Login Attempts: 0
      Login Failures: 0
      Lockout Attempts: 0
      Account Expiry:      Password Expiry:
Is information correct? (Yes, No, Quit): [Yes]
```

User 'ppp\_user1' has been added

**tunnel tunnel-name**

Gives a tunnel peer access through an IP network to the router. The peer is then authorized to initiate tunneled PPP sessions into the router. To configure a tunnel you must specify:

**Name** The hostname of the tunnel peer.

**Hostname to use when connecting to this peer**

The local hostname to use when connecting to this peer. This name is used for identification of the host on the peer.

**Set shared secret**

Specifies whether a shared secret is to be used.

**Shared Secret**

The secret shared between the LAC and LNS. It must be exactly the same on both ends of the tunnel.

**Enter again to verify**

Enter the shared secret again for verification.

**Tunnel-Server endpoint address**

The IP address of the tunnel peer (LAC or LNS).

**Example:**

## CONFIG Commands

```
Config> add tunnel
Enter name: []? tunnel02
Enter hostname to use when connecting to this peer: []? host02
Set shared secret? (Yes, No): [No]? yes
Shared secret for tunnel authentication:
Enter again to verify:
Tunnel-Server endpoint address: [0.0.0.0]? 2.2.2.22
```

```
Tunnel name: tunnel02
Endpoint: 2.2.2.22
```

### **user** *user\_name*

Gives a user access to the device. You can authorize up to 50 users to access the device. Each *user\_name* is eight characters and is case-sensitive.

When the first user is added, console login is automatically enabled. Each user added must be assigned one of the permission levels defined in Table 8.

When users are added, set login authentication to local. Otherwise a remote server must be used.

Table 8. Access Permission

Permission Level	Description
Administrator (A)	Displays configuration and user information, adds/modifies/deletes configuration and user information. The Administrator can access any router function.
Operator (O)	Views router configuration, views statistics, runs potentially disruptive tests, dynamically changes router operation, and restarts the router. Operators cannot modify the permanent router configuration. All actions can be undone with a system restart.
Monitor (M)	Views router configuration and statistics but cannot modify or disrupt the operation of the router.
Tech Support	Allows your service representative to gain access to the router if a password is forgotten. Cannot be assigned to users.

**Note:** To add a user, you must have administrative permission. You do not have to reinitialize the router after adding a user.

### **Example:**

```
add user John
Enter password:
Enter password again:
Enter permission (A)admin, (O)perations, (M)onitor [A]?
Do you want to add Technical Support access? (Yes or [No]):
```

### **Enter password**

Specifies the access password for the user. Limited to 80 alphanumeric characters and is case-sensitive.

### **Enter password again**

Confirms the access password for the user.

### **Enter permission**

Specifies the permission level for the user: A, O, or M (see Table 8).

### **v25-bis-address**

Adds the local and remote numbers of the V.25 bis end-points that communicate with the router. The network *address-name* can be anything, such as a description of the port. You can use any string of up to 23 printable ASCII characters. The *network-dial-address* is the telephone

number of the local or destination port. For more information, see “Chapter 50. Using the V.25 bis Network Interface” on page 701.

**Note:** You can use punctuation, such as parentheses and dashes, but the punctuation is not significant (the router uses only the numbers).

Example: add v25-bis-address  
remote-site baltimore 1-909-555-0983

## Boot

Use the **boot** command to enter the Boot CONFIG command environment. For Boot CONFIG information, see “Chapter 5. Using BOOT Config to Perform Change Management” on page 45.

**Syntax:**

**boot**

## Change

Use the **change** command to modify an interface in the configuration, change your own password, or change user information.

**Syntax:**

```
change                device . . .
                       password
                       ppp_user . . .
                       tunnel-profile
```

**device** *device\_type*

With the **change device** command you can:

- Change the slot of an existing interface. (Change slot x in interface record n to y where slot y is unoccupied.)
- Change the port of an existing interface. (Change port x in interface record n to y where port y is unoccupied.)
- Swap slots of two existing interfaces. (Swap slot x and slot y in interface records with x or y.)
- Swap ports of two existing interfaces. (Swap port u and slot x in one interface record with port v and slot y in another interface record of the same hardware type.)
- Replace the slot in an existing interface with the slot in another. (Interface configuration for slot x will become interface configuration for slot y. Interface records for slot y will be deleted.)
- Replace the port of one existing interface with the port of another. (Interface configuration for slot x port u will become interface configuration for slot y port v. The interface record for slot y port v will be deleted.)

When the target slot is occupied:

1. If you select the “swap” option, the source and target slots are swapped in all the interface records in which they appear.
2. If you select the “replace” option is selected, the interface configuration for slot x will become the interface configuration for slot y. Interface records for slot y will be deleted.

## CONFIG Commands

When the target port is occupied:

1. If you select the “swap” option, the source and target ports can be swapped in their respective interface records if their hardware types in these interface records are identical. For example, 1-port ISDN T1/J1.
2. If you select the “replace” option, the interface configuration for slot x port u becomes the interface configuration for slot y port v. The interface record for slot y port v is deleted.

**Note:** An Ethernet or Token Ring adapter card requires two empty slots if it is installed in slot 3, 4, 7, or 8. Therefore a Token Ring or Ethernet adapter can be installed in slot 3 or 4 (or slot 7 or 8) only if both slots 3 and 4 (or 7 and 8) are unoccupied.

If you try to change the slot of a Token Ring or Ethernet adapter to slot 3 or 4 (or 7 or 8) when both 3 and 4 (or 7 and 8) are not unoccupied, the change is not accepted and a warning message is issued as shown in the example “Change slot 6 on interface 1 to unoccupied slot 8” on page 81.

### Example - Change (replace) slot 1 on interface 1 to occupied slot 2:

```
Config>list dev
Ifc 0 CHARM ATM          Slot: 2 Port: 1
Ifc 1 CHARM ATM          Slot: 1 Port: 1

Config>change device
Which configured slot would you like to change? (1, 2) [2]? 1
Which slot would you like to change to? (1-2) [1]? 2

Configuration for slot 2 already exists. You can:
a - abort this operation
r - replace configuration
   (Interface configuration for slot 1 will become interface
   configuration for slot 2. Interface records for slot 2
   will be deleted!)
s - swap configuration (slot 1 will be swapped with slot 2.)
r

Moved slot 2 to slot 1 in 1 intf (port) record...

Config>list dev
Ifc 0 CHARM ATM          Slot: 2 Port: 1
```

### Example - Change slot 5 on interface 0 to unoccupied slot 7:

```
Config>list dev
Ifc 0 Token Ring          Slot: 5 Port: 1
Ifc 1 Token Ring          Slot: 6 Port: 1
Ifc 2 Token Ring          Slot: 1 Port: 1
Ifc 3 8 port EIA-232E/V.24 PPP Slot: 2 Port: 0
Ifc 4 8 port EIA-232E/V.24 PPP Slot: 2 Port: 1
Ifc 5 8 port EIA-232E/V.24 PPP Slot: 2 Port: 2
Ifc 6 6 port V.35/V.36 PPP  Slot: 3 Port: 0
Ifc 7 6 port V.35/V.36 PPP  Slot: 3 Port: 5
Ifc 8 8 port EIA-232E/V.24 PPP Slot: 4 Port: 0

Config>change device
Which configured slot would you like to change? (1, 2, 3, 4, 5, 6)[1]? 5
Change all ports on slot # 5 (Yes or No)? [Yes]: y
Which slot would you like to change to? (1-8) [1]? 7

Changed slot 5 to slot 7 in 1 intf (port) record...

Config>list dev
Ifc 0 Token Ring          Slot: 7 Port: 1
Ifc 1 Token Ring          Slot: 6 Port: 1
Ifc 2 Token Ring          Slot: 1 Port: 1
Ifc 3 8 port EIA-232E/V.24 PPP Slot: 2 Port: 0
Ifc 4 8 port EIA-232E/V.24 PPP Slot: 2 Port: 1
Ifc 5 8 port EIA-232E/V.24 PPP Slot: 2 Port: 2
Ifc 6 6 port V.35/V.36 PPP  Slot: 3 Port: 0
Ifc 7 6 port V.35/V.36 PPP  Slot: 3 Port: 5
Ifc 8 8 port EIA-232E/V.24 PPP Slot: 4 Port: 0
```

Interface 0 is now changed to slot 7.

**Example - Change slot 6 on interface 1 to unoccupied slot 8:**

```
Config>change device
Which configured slot would you like to change? (1, 2, 3, 4, 6, 7)[1]? 6
Change all ports on slot # 6 (Yes or No)? [Yes]: y
Which slot would you like to change to? (1-8) [1]? 8
```

Cannot add Token Ring to slot 8.  
Slot 7 is occupied so Token Ring cannot be added in slot 8.

**Note:** See the note on 2 on page 80 for requirements for changing slots 3, 4, 7, and 8 for Token Ring or Ethernet.

**Example - Swap slot 6 on interface 1 to occupied slot 1:**

```
Config>change device
Which configured slot would you like to change? (1, 2, 3, 4, 6, 7) [1] 6
Change all ports on slot # 6 (Yes or No)? [Yes]: y
Which slot would you like to change to? (1-8) [1]? 1
```

Configuration for slot 1 already exists. You can:  
a - abort this operation  
r - replace configuration  
    (Interface configuration for slot 6 will become interface  
    configuration for slot 1. Interface records for slot 1  
    will be deleted!)

s - swap configuration (slot 1 will be swapped with slot 6.)  
s

Swapped slot 6 with slot 1 in 1 port record...

```
Config>list dev
Ifc 0 Token Ring                Slot: 7 Port: 1
Ifc 1 Token Ring                Slot: 1 Port: 1
Ifc 2 Token Ring                Slot: 6 Port: 1
Ifc 3 8 port EIA-232E/V.24 PPP  Slot: 2 Port: 0
Ifc 4 8 port EIA-232E/V.24 PPP  Slot: 2 Port: 1
Ifc 5 8 port EIA-232E/V.24 PPP  Slot: 2 Port: 2
Ifc 6 6 port V.35/V.36 PPP      Slot: 3 Port: 0
Ifc 7 6 port V.35/V.36 PPP      Slot: 3 Port: 5
Ifc 8 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 0
```

The configurations for interface 2 and interface 1 are swapped.

**Example - Slot 1 on interface 1 replaces slot 6, interface 1 is deleted:**

```
Config>change device
Which configured slot would you like to change? (1, 2, 3, 4, 6, 7) [1] 6
Change all ports on slot # 6 (Yes or No)? [Yes]: y
Which slot would you like to change to? (1-8) [1]? 1
```

Configuration for slot 1 already exists. You can:  
a - abort this operation  
r - replace configuration  
    (Interface configuration for slot 6 will become interface  
    configuration for slot 1. Interface records for slot 1  
    will be deleted!)

s - swap configuration (slot 1 will be swapped with slot 6.)  
r

Moved slot 6 to slot 1 in 1 intf (port) record...

```
Config>list dev
Ifc 0 Token Ring                Slot: 7 Port: 1
Ifc 1 Token Ring                Slot: 1 Port: 1
Ifc 2 8 port EIA-232E/V.24 PPP  Slot: 2 Port: 0
Ifc 3 8 port EIA-232E/V.24 PPP  Slot: 2 Port: 1
Ifc 4 8 port EIA-232E/V.24 PPP  Slot: 2 Port: 2
Ifc 5 6 port V.35/V.36 PPP      Slot: 3 Port: 0
Ifc 6 6 port V.35/V.36 PPP      Slot: 3 Port: 5
Ifc 7 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 0
```

The slot 6 record replaces the original slot 1 record and the other interfaces are renumbered.

**Example - Change slot 2 to unoccupied slot 5:**

## CONFIG Commands

```
Config>change device
Which configured slot would you like to change? (1, 2, 3, 4, 7) [1]? 2
Change all ports on slot # 2 (Yes or No)? [Yes]: y
Which slot would you like to change to? (1-8) [1]? 5

Changed slot 2 to slot 5 in 3 intf (port) records...
```

```
Config>list dev
Ifc 0 Token Ring                Slot: 7 Port: 1
Ifc 1 Token Ring                Slot: 1 Port: 1
Ifc 2 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 0
Ifc 3 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 1
Ifc 4 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 2
Ifc 5 6 port V.35/V.36 PPP      Slot: 3 Port: 0
Ifc 6 6 port V.35/V.36 PPP      Slot: 3 Port: 5
Ifc 7 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 0
```

Interfaces 2, 3 and 4 that were previously configured in slot 2 are now configured in slot 5.

### Example - Change port 1 slot 5 to port 0 in unoccupied slot 2:

```
Config>change device
Which configured slot would you like to change? (1, 3, 4, 5, 7) [1]? 5
Change all ports on slot # 5 (Yes or No)? [Yes]: n
Which port would you like to change in slot 5? (0, 1, 2) [0]? 1
Which slot would you like to change to? (1-8) [1]? 2
Which port would you like port 1 in slot 5 to move to in slot2?#(0-7)[0]? 0

Changed slot 5 port 1 to slot 2 port 0...
```

```
Config>list dev
Ifc 0 Token Ring                Slot: 7 Port: 1
Ifc 1 Token Ring                Slot: 1 Port: 1
Ifc 2 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 0
Ifc 3 8 port EIA-232E/V.24 PPP  Slot: 2 Port: 0
Ifc 4 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 2
Ifc 5 6 port V.35/V.36 PPP      Slot: 3 Port: 0
Ifc 6 6 port V.35/V.36 PPP      Slot: 3 Port: 5
Ifc 7 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 0
```

Interface 3, which was at slot 5 - port 1, is changed to slot 2 port 0.

### Example - Change port 0 slot 2 to port 5 in slot 3 (different hardware types):

```
Config>change device
Which configured slot would you like to change? (1, 2, 3, 4, 5, 7) [1]? 2
Change all ports on slot # 2 (Yes or No)? [Yes]: n
Which port would you like to change in slot 2? (0) [0]? 0
Which slot would you like to change to? (1-8) [1]? 3
Which port would you like port 0 in slot 2 to move to in slot 3? #(0-7) [0] 5

Aborting - source and target slots of different type.
```

### Example - Change port 0 slot 2 to port 5 in slot 4 (same hardware types):

```
Config>change device
Which configured slot would you like to change? (1, 2, 3, 4, 5, 7) [1]? 2
Change all ports on slot # 2 (Yes or No)? [Yes]: n
Which port would you like to change in slot 2? (0) [0]? 0
Which slot would you like to change to? (1-8) [1]? 4
Which port would you like port 0 in slot 2 to move to in slot 4? #(0-7)[0] 5

Changed slot 2 port 0 to slot 4 port 5...
```

```
Config>list dev
Ifc 0 Token Ring                Slot: 7 Port: 1
Ifc 1 Token Ring                Slot: 1 Port: 1
Ifc 2 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 0
Ifc 3 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 5
Ifc 4 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 2
Ifc 5 6 port V.35/V.36 PPP      Slot: 3 Port: 0
Ifc 6 6 port V.35/V.36 PPP      Slot: 3 Port: 5
Ifc 7 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 0
```

Interface 3 which was at port 0, slot 2 is changed to port 5, slot 4.

### Example - Change port 5 slot 4 to port 1 in slot 4 (same slots):



```
Config>change device
Which configured slot would you like to change? (1, 3, 4, 5, 7) [1]? 4
Change all ports on slot # 4 (Yes or No)? [Yes]: n
Which port would you like to change in slot 4? (0, 5) [0]? 5
Which slot would you like to change to? (1-8) [1]? 4
Which port would you like port 5 in slot 4 to move to in slot 4? #(0-7) [0] 1

Changed slot 4 port 5 to slot 4 port 1...
```

```
Config>list dev
Ifc 0 Token Ring                Slot: 7 Port: 1
Ifc 1 Token Ring                Slot: 1 Port: 1
Ifc 2 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 0
Ifc 3 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 1
Ifc 4 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 2
Ifc 5 6 port V.35/V.36 PPP      Slot: 3 Port: 0
Ifc 6 6 port V.35/V.36 PPP      Slot: 3 Port: 5
Ifc 7 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 0
```

Interface 3 is now at port 1, slot 4.

### Example - Change (swap) port 1 slot 4 to occupied port 0 in slot 5:

```
Config>change device
Which configured slot would you like to change? (1, 3, 4, 5, 7) [1]? 4
Change all ports on slot # 4 (Yes or No)? [Yes]: n
Which port would you like to change in slot 4? (0, 1) [0]? 1
Which slot would you like to change to? (1-8) [1]? 5
Which port would you like port 1 in slot 4 to move to in slot 5? #(0-7) [0] 0

Configuration for slot 5 (port 0) already exists. You can:
a - abort this operation
r - replace configuration
    (Interface record for slot 4 port 1 will become interface
    configuration for slot 5 port 0. The interface record for
    slot 5 port 0 will be deleted!)
s - swap configuration (slot 5 port 0 will be swapped with slot 4
    port 1.)
s

Swapped slot 4 port 1 with slot 5 port 0...
```

```
Config>list dev
Ifc 0 Token Ring                Slot: 7 Port: 1
Ifc 1 Token Ring                Slot: 1 Port: 1
Ifc 2 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 1
Ifc 3 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 0
Ifc 4 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 2
Ifc 5 6 port V.35/V.36 PPP      Slot: 3 Port: 0
Ifc 6 6 port V.35/V.36 PPP      Slot: 3 Port: 5
Ifc 7 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 0
```

Interface 2 and interface 3 have swapped their port and slot configurations.

### Example - Change (replace) port 1 slot 4 to occupied port 0 in slot 5:

```
Config>change device
Which configured slot would you like to change? (1, 3, 4, 5, 7) [1]? 4
Change all ports on slot # 4 (Yes or No)? [Yes]: n
Which port would you like to change in slot 4? (0, 1) [0]? 1
Which slot would you like to change to? (1-8) [1]? 5
Which port would you like port 1 in slot 4 to move to in slot 5? #(0-7) [0] 0

Configuration for slot 5 (port 0) already exists. You can:
a - abort this operation
r - replace configuration
    (Interface configuration for slot 4 port 1 will become interface
    configuration for slot 5 port 0. The interface record for
    slot 5 port 0 will be deleted!)
s - swap configuration (slot 5 port 0 will be swapped with slot 4
    port 1.)
r

Moved slot 4 port 1 to slot 5 port 0...
```

```
Config>list dev
Ifc 0 Token Ring                Slot: 7 Port: 1
Ifc 1 Token Ring                Slot: 1 Port: 1
Ifc 2 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 0
Ifc 3 8 port EIA-232E/V.24 PPP  Slot: 5 Port: 2
Ifc 4 6 port V.35/V.36 PPP      Slot: 3 Port: 0
Ifc 5 6 port V.35/V.36 PPP      Slot: 3 Port: 5
Ifc 6 8 port EIA-232E/V.24 PPP  Slot: 4 Port: 0
```

## CONFIG Commands

Interface 2 is configured to slot 5 - port 0. The original interface 3 is deleted and the other interfaces are renumbered.

### password

Modifies the password of the user who is now logged in.

**Note:** To change a user password, you must have administrative permission.

#### Example:

```
change password
Enter current password:
Enter new password:
Enter new password again:
```

#### Enter current password

Specifies your current password.

#### Enter new password

Specifies your new password.

#### Enter new password again

Specifies your new password again for confirmation. If your confirmation does not match the previous new password, the old password remains in effect.

### ppp\_user

Changes the information for a specific PPP user.

#### Syntax:

```
change ppp_user           encryption-key
                               parameters
                               password
```

#### encryption-key

Changes the encryption key for a PPP user. The following example shows the dialog for changing an encryption key.

#### Example - Change Encryption key:

```
Config>change ppp_user encryption-key
Enter user name: [ ]? leslie
Enable encryption for this user/port (y/n) [No]:y
Encryption key should be 16 characters long.
Encryption Key (16 characters ) in Hex(0-9, a-f, A-F):
Encryption Key again (16 characters) in Hex(0-9, a-f, A-F):
User 'leslie' has been updated
Config>
```

#### parameters

Changes all of the ppp-user options for a user. This parameter works similar to the **add ppp\_user** except that the values shown within the [ ] are the current values and the change command does not verify the changes or list them back to you when you are done. See "Add" on page 72 for details about the **add ppp\_user** command.

#### password

Changes the password for the PPP user.

#### Example - Change password:

```
Config>change ppp_user password
Enter user name: [ ]? sam
Password:
Enter password again:
User 'sam' has been updated
Config>
```

**user** Modifies the user information that was previously configured with the **add user** command.

**Note:** To change a user, you must have administrative permission.

**Example:**

```
change user
User name: []
Change password? (Yes or No)
Change permission? (Yes or [No])
```

**tunnel-profile**

Changes the configuration for a tunnel peer.

```
Config>change tunnel-profile
Enter name: []? lac.org
Enter hostname to use when connecting to this peer: [lns.org]?
set shared secret? (Yes, No): [No]
Tunnel-Server endpoint address: [11.0.0.1]? 11.0.0.2

profile 'lac.org' has been updated
Config>
```

## Clear

Use the **clear** command to delete the device's configuration information from nonvolatile configuration memory.

**Attention:** Use this command only after calling your service representative.

**Syntax:**

```
clear
    all
    ap2 (AppleTalk 2)
    arp (ARP)
    asrt (Adaptive Source Route Protocol)
    appn (Advanced Peer-to-Peer Networking)
    atm (Asynchronous Transfer Mode)
    auth (Authentication)
    bgp (Border Gateway Protocol)
    boot
    brs (Bandwidth Reservation)
    callback
    cmprs (Data Compression)
    dls (Data Link Switching)
    device
    dialer-circuit
    dn (DECnet)
    els (Event Logging System Information)
    fr (Frame Relay)
    gsmp (OSI)
    hdlc
```

## CONFIG Commands

hod (Host On-Demand Client Cache) \*

hostname

ip (IP)

ip-security

ipv6

ipx (Novell IPX)

isdn

l2tp

lnm

mcf

named-profiles

nat

ndp6

ndr

osi (OSI)

ospf (OSPF routing protocol)

ppp (Point-to-Point)

prompt

rip6

rsvp

sdlc

snmp

srly (SDLC Relay)

tcp/ip-host

time (Time of day information)

tsf (Thin Server)

user

v25bis

vines (Banyan VINES)

webc (Web Server Cache) \*

wrs (WAN Restoral feature)

x25

xtp

**\*Note:** HOD and WEBC do not coexist in the same software image.

To clear a process from nonvolatile configuration memory, enter the **clear** command and the process name. To clear all information from configuration memory, except

for device information, use the **clear all** command. To clear all information, including the device information, use the **clear all** command and then the **clear device** command.

The **clear user** command clears all user information except the device console login information. This is left as enabled (if it was configured as enabled) even though the default value is “disabled”.

**Notes:**

1. To clear user information, you must have administrative permission.
2. There may be other items in the list, depending upon what is included in the software load.

**Example: clear els**

You are about to clear all Event Logging configuration information  
Are you sure you want to do this (Yes or No):

**Note:** The previous message appears for any parameter configuration you are clearing.

## Delete

Use the **delete** command to remove an interface or range of interfaces from the list of devices stored in the configuration, or to remove a user. To use the **delete** command, you must have administrative permission.

**Syntax:**

```

delete          _coprocessor . . .
                _interface . . .
                _dump-files
                _isdn-address
                _ppp_user . . .
                _tunnel
                _user . . .
                _v25-bis-address
    
```

**interface [intfc# or intfc#range]**

To delete an interface, enter the interface or network number as part of the command. (Only devices that were added with the **add device** command can be deleted.) To obtain the interface number that the device assigns, use the **list device** command.

The delete interface command deletes the device configuration and any protocol information for that interface. However, the device will continue to run the previous configuration until it is reloaded.

If deleting a base ISDN interface or a base ATM interface, all virtual interfaces running on that base net will also be deleted. So, any dial circuits configured on a base ISDN interface will be removed when the ISDN interface is deleted. Also, when deleting an ATM base net, all LAN Emulation Clients running on the base ATM interface will be deleted.

To delete a range of interfaces, specify the first and last interface in the range separated by a hyphen, as shown in the following example:

```
delete interface 13-21
```

## CONFIG Commands

You can also enter an interface number or range of interface numbers, when prompted.

### **isdn-address** *address-name*

Removes a previously added ISDN address.

**Note:** If the *address-name* contains spaces (for example, **remote site XYZ**), you cannot enter the command on one line. Type `delete isdn-address` and press **Return**. Then enter the name when prompted.

### **ppp\_user** *user\_name*

Deletes a user from the PPP user data base.

### **tunnel-profile**

Deletes a tunnel from the tunnel profile database.

### **user** *user\_name*

Removes user access to the device for the specified user.

### **v25-bis-address** *address-name*

Removes a previously added V25bis address.

**Note:** If the *address-name* contains spaces (for example, **remote site Baltimore**), you cannot enter the command on one line. Type `delete v25-bis-address` and press **Return**. Then enter the name when prompted.

## Disable

Use the **disable** command to disable command completion, login from a remote console, disables modem use

### **Syntax:**

```
disable                command-completion  
                        console-login  
                        dump-memory . . .  
                        interface . . .  
                        reboot-system . . .
```

### **command-completion**

Use the **disable command-completion** command to disable the automatic command completion function. See “Command Completion” on page 22 for a discussion of the automatic command completion function.

**Note:** Command completion defaults to *disabled* for existing configurations and defaults to *enabled* for new configurations. If you are using an existing configuration and want to use command completion, you need to use the **enable command-completion** command to enable this function.

### **console-login**

Disables the user from being prompted for a user ID and password on the physical console. The default is disabled.

**interface** *interface#*

Causes the specified interface to be disabled after issuing the **reload** command. The default is enabled.

**dump-memory**

Disables the dumping of system memory to the installed hard disk when a serious error occurs.

**reboot-system**

Disables the rebooting of the system when a serious error occurs. This may be desirable if the network service personnel wish to troubleshoot the error on-line. System rebooting cannot be disabled unless memory dumping is also disabled. If you attempt to disable system rebooting while memory dumping is enabled, system rebooting is aborted and the following message is displayed:

System reboot not disabled: memory dumping must be disabled first

## Enable

Use the **enable** command to enable command completion, login from a remote console, disables modem use

**Syntax:**

```
enable                command-completion
                    console-login
                    dump-memory . . .
                    interface . . .
                    reboot-system . . .
```

**command-completion**

Use the **enable command-completion** command to enable the automatic command completion function, which assists with the command syntax. See “Command Completion” on page 22 for a discussion of the automatic command completion function.

**console-login**

Enables the user to be prompted for a user ID and password on the physical console. This is useful for security situations. If you do not configure any administrative users and you enable this feature, the following message appears:

Warning: Console login is disabled until an administrative user is added.

**Attention:** Before enabling console login, save the configuration with console login disabled. If login authentication is set to a remote server using Radius or Tacacs+ and the device is unable to reach the authentication server, then access to the device is denied. By disabling the console login, a lock-out situation is prevented.

**dump-memory**

Enables the dumping of system memory to the installed hard disk if a serious error occurs. This may be desirable so that the state of the unit at the time of the error can be preserved for troubleshooting later. The dump memory function cannot be enabled unless system rebooting is enabled. If

## CONFIG Commands

you attempt to enable the dump memory function while system rebooting is disabled, the dump memory function is not enabled and the following message is displayed:

```
System memory dump function not enabled: rebooting must be enabled first
```

If you configured system dumping to save the first 3 dump files and 3 dump files already exist on the hard drive, the system displays the following message when you enable dump memory:

```
*** System dump cannot be enabled until the ***
*** existing dump files are deleted.      ***
```

See the **set dump enable-mode** and **set dump save-mode** commands.

### Example:

```
Config> enable dump
```

```
Current System Dump Status:
System dump is currently disabled.
Number of existing dump files: 0
```

```
Enable system memory dumping? [No]: Yes
```

```
Current System Dump Status:
System dump is currently enabled.
Number of existing dump files: 0
```

**Note:** If you enter this command and a hard drive is not available, you will receive a message indicating that the drive is unavailable.

### **interface** *interface#*

Causes the interface to be enabled after issuing the **reload** command.

### **reboot-system**

Enables the rebooting of the system when a serious error occurs.

## Event

Use the **event** command to enter the Event Logging System (ELS) environment so that you can define the messages that will appear on the console. Refer to “Chapter 10. Using the Event Logging System (ELS)” on page 127 for information about ELS.

### **Syntax:**

**event**

## Feature

Use the **feature** command to access configuration commands for specific device features outside of the protocol and network interface configuration processes.

### **Syntax:**

**feature** *[feature# or feature-short-name]*

All 2216 features have commands that are executed by:

- Accessing the configuration process to initially configure and enable the feature, as well as perform later configuration changes.
- Accessing the console process to monitor information about each feature, or make temporary configuration changes.



## CONFIG Commands

The procedure for accessing these processes is the same for all features. The following information describes the procedure.

Enter a question mark after the **feature** command to obtain a listing of the features available for your software release.

To access a feature's configuration prompt, enter the **feature** command followed by the feature number or short name. Table 9 lists available feature numbers and names.

Table 9. IBM 2216 Feature Numbers and Names

Feature Number	Feature Short Name	Accesses the following feature configuration process
0	WRS	WAN Restoral/Reroute
1	BRS	Bandwidth Reservation
2	MCF	MAC Filtering
4	VCRM	Virtual Circuit and Resource Management
7	ES	Encoding Subsystem
8	NDR	Network Dispatcher
9	DIALs	Dial-In-Access to LANs
10	AUTH	Authentication
11	IPSec	IP Security feature user configuration
12	LAYER	Layer 2 Tunneling Protocol, Layer 2 Filtering, Point-to-Point Tunneling Protocol
13	NAT	Network Address Translator user configuration
14	TSF	Thin Server Function
15	WEBC	Web Server Cache <sup>1</sup>
15	HOD	Host on Demand Client Cache <sup>1</sup>
16	DHCP	DHCP Services
20	POLICY	Policy feature
21	DS	Differentiated services
22	RED	Random early detection

<sup>1</sup>HOD and WEBC do not coexist in the same software image; that is why they have the same feature number.

Once you access the configuration prompt for a feature, you can begin entering specific configuration commands for the feature. To return to the CONFIG prompt, enter the **exit** command at the feature's configuration prompt.

## List

Use the **list** command to display configuration information for all network interfaces, or configuration information for the device.

### Syntax:

```
list                configuration  
                    devices  
                    named-profile
```

## CONFIG Commands

isdn-address  
patches . . .  
ppp\_users . . .  
tunnel-profile  
users . . .  
v25-bis-address  
vpd

### configuration

Displays configuration information about the device.

#### Example: list configuration

```
Hostname: [none]
Maximum packet size: [autoconfigured]
Maximum number of global buffers: [autoconfigured]
Number of spare interfaces: 0
Console inactivity timer (minutes): 0
Physical console login: disabled
System rebooting on error: disabled
System memory dumping: disabled
Contact person for this node: [none]
Location of this node: [none]

Configurable Protocols:
Num Name Protocol
0 IP DOD-IP
3 ARP Address Resolution
4 DN DNA Phase IV
6 VIN Banyan Vines
7 IPX NetWare IPX
8 OSI ISO CLNP/ISIS/ISIS
9 DVM Distance Vector Multicast Routing Protocol
10 BGP Border Gateway Protocol
11 SNMP Simple Network Management Protocol
12 OSPF Open SPF-Based Routing Protocol
20 SDLC SDLC/HDLC-Relay
22 AP2 AppleTalk Phase 2
23 ASRT Adaptive Source Routing Transparent Enhanced Bridge
24 HST TCP/IP Host Services
25 LNM LAN Network Manager
26 DLS Data Link Switching
27 XTP X.25 Transport Protocol
28 APPN Advanced Peer-to-Peer Networking [HPR]
29 NHRP Next Hop Routing Protocol
30 APPN Advanced Peer-to-Peer Networking [ISR]

Configurable Features:
Num Name Feature
0 WRS WAN Restoral
1 BRS Bandwidth Reservation
2 MCF MAC Filtering
6 QOS Quality of Service
7 CMPRS Data Compression Subsystem
8 NDR Network Dispatching Router
10 AUTH Authentication
14 TSF Thin Server Function

26176 bytes of configuration memory free
```

### devices [*device or devicerange*]

Displays the relationship between an interface number and the hardware interface. You can also use this command to check that a device was added correctly issuing the **add** command.

You can also specify a range of devices to list as shown in the following example:

```
list dev 2-5
Ifc 2 Token Ring Slot: 2 Port: 1
Ifc 3 Token Ring Slot: 2 Port: 2
Ifc 4 Ethernet Slot: 4 Port: 1
Ifc 5 Ethernet Slot: 4 Port: 2
```

**Note:** If you do not specify an interface number or a range of interfaces, all interfaces are displayed.

**Example: list devices**

```

Ifc 0 Token Ring           Slot: 1 Port: 1
Ifc 1 Token Ring           Slot: 1 Port: 2
Ifc 2 Token Ring           Slot: 2 Port: 1
Ifc 3 Token Ring           Slot: 2 Port: 2
Ifc 4 Ethernet             Slot: 4 Port: 1
Ifc 5 Ethernet             Slot: 4 Port: 2
Ifc 6 Ethernet             Slot: 5 Port: 1
Ifc 7 Ethernet             Slot: 5 Port: 2
Ifc 8 Ethernet             Slot: 6 Port: 1
Ifc 9 Ethernet             Slot: 6 Port: 2
Ifc 10 V.35/V.36 Frame Relay Slot: 8 Port: 0
Ifc 11 V.35/V.36 X.25      Slot: 8 Port: 1
Ifc 12 V.35/V.36 PPP       Slot: 8 Port: 2
Ifc 13 V.35/V.36 PPP       Slot: 8 Port: 3
Ifc 14 V.35/V.36 PPP       Slot: 8 Port: 4
Ifc 15 V.35/V.36 PPP       Slot: 8 Port: 5
    
```

**Note:** The number of receive buffers noted are exceptions from the receive buffer defaults. The **set receive buffers** command is discussed under "Set" on page 99.

**isdn-address**

Displays the current ISDN address configurations.

```

Example: list isdn-address
Address assigned name      Network Address      Network Subdial Address
-----
remote site XYZ            1 2345 67            98765
    
```

**patches**

Displays the values of patch variables that have been entered using the **patch** command.

**Example:**

```

list patches
Patched variable          Value
-----
ping-size                  60
ping-ttl                   59
ethernet-security         3
    
```

**ppp\_users**

Lists specific PPP user profile parameters.

**Example:** List of PPP users when DIALs is not in the software load

```

Config> list ppp_users
List (Name, Verb, User, Addr, Encr):

      PPP User Name: joe
      User IP Address: Interface Default
      Encryption: Not Enabled
    
```

**Example:** List of PPP users when DIALs is in the software load

```

Config> list ppp_users
List (Name, Verb, User, Addr, Call, Time, Dial, Encr):

      PPP User Name: joe
      User IP Address: Interface Default
      Net-Route Mask: 255.255.255.255
      Hostname: <undefined>
      Time-Allotted: Box Default
      Call-Back Type: Not Enabled
      Dial-Out: Not Enabled
      Encryption: Not Enabled
    
```

When you enter **list ppp\_users**, the software will prompt you to enter one of the following:

## CONFIG Commands

**Name** List all of the names in the database.

**Verb** List verbose information about each user. List all information pertaining to each user profile.

**User** List verbose information about a single user.

**Addr (address)**

List IP address information for each user, including IP Address, net mask and hostname.

**Call (callback)**

List callback information for each user, including the type of callback and number.

**Time** List time allowed configured for each user.

**Encr (encryption)**

List whether encryption is enabled for each user.

### tunnel-profile

Displays the tunnel-profile parameters.

**Example:**

```
Config>list tunnel-profile
Endpoint Tunnel name Hostname
11.0.0.192 tac lns
1 TUNNEL record displayed.
Config>
```

**Tunnel Name**

Specifies the configured name for the peer.

**Server Endpoint**

The IP address of the peer.

**Type** Specifies the type of peer connection.

**Medium**

Specifies the protocol that the tunnel is using.

**Local Host Name**

Specifies the name configured for use when connecting to the peer.

**users** Displays the users configured to access the system.

**Example:**

```
list users
USER          PERMISSION
joe           operations
mary          administrative
peter         monitor
```

### v25-bis-address

Displays the current V25bis address configurations. The V25bis address configuration consists of the network address and network address name for a local port (serial line interface) or destination port. The network address is the telephone number of the local or destination port. The network address name can be anything, such as the description of the port. See "Chapter 50. Using the V.25 bis Network Interface" on page 701 for more information.

```
Example:
list v25-bis-address
Address assigned name      Network Address
-----
```

v25-1	8982800
v25-2	8980001
delaware	1-666-555-4444

**vpd** Displays the hardware and software vital product data.

## Load

Use the **load** command to list packages in the software load that are available but not configured, or packages that are configured in the software load. The **load** command is also used to add or delete a software package.

### Syntax:

```

load          add package packagename
              delete package packagename
              list . . .
  
```

The software is divided into multiple load modules. These load modules are grouped into software packages. Some of these software packages are optional because, although they are shipped with the product, they are not automatically loaded.

Software packages containing encryption are available from the 2216 Web server accessible using the Internet.

To load and run optional software packages:

1. Add the package using the **load add** command.
2. Reboot. This action loads the optional software into the device's memory.
3. Configure the optional software.
4. Save the configuration.
5. Reboot the device. This action enables the software with the new configuration.

### **add package** *packagename*

Adds a software package to the software. The *packagename* is the name of the package of load modules you want to include in the software.

#### **Example: load add package appn**

### **delete package** *packagename*

Removes a software package from the software. The *packagename* is the name of the package of load modules you want to remove from the software.

#### **Example: load delete package appn**

**list** Lists either the packages in the software load that are available but not configured, or the packages that are configured in the software load. You can specify one of the following:

#### **available**

Lists the software packages in the current software load that are not configured.

#### **configured**

Lists the software packages in the current software load that are configured.

## CONFIG Commands

### Network

Use the **network** command to enter the network interface configuration environment for supported networks. Enter the interface or network number as part of the command. (To obtain the interface number, use the CONFIG **list device** command.) The appropriate configuration prompt (for example, TKR Config>) will be displayed. See the network interface configuration chapters in this book for complete information on configuring your types of network interfaces.

#### Syntax:

**network** *interface#*

#### Notes:

1. If you change a user-configurable parameter, you may use the GWCON **reset interface** command, or you may reload the device for the change to take effect. To do so, enter the **reload** command at the OPCON prompt (\*).
2. Not all network interfaces are user-configurable. For interfaces that you cannot configure, you receive the message: That network is not configurable.

### Patch

Use the **patch** command for modifying the device's global configuration. Patch variables are recorded in nonvolatile configuration memory and take effect immediately; you do not have to wait for the next restart of the device. This command should be used only for handling uncommon configurations. Anything that you commonly configure should still be handled by using the specific configuration commands. The following is a list of the current patch variables documented and supported for this release.

#### Syntax:

**patch** bgp-subnets  
dls-ignore-lfs  
ethernet-security  
filter-nr  
ip-default-ttl  
ip-mtu  
lnm-link-via-tbport  
more-lines  
mosheap-lowmark  
ospf-import-rate  
ping-size  
ping-ttl  
ppp-echo  
relax-jate  
rip-static-suppress  
tftp-max-rxto-time  
tftp-min-rexmtime

### **bgp-subnets** *new value*

If you want the BGP speaker to advertise subnet routes to its neighbors, set *new value* to 1. The default is 0.

### **dls-ignore-lfs** *new value*

When set to 1, DLSw ignores the “largest frame” size bits in source-routed frames when setting up a circuit. This avoids circuit setup problems with some older LAN products that do not set these bits correctly. The default is 0.

### **ethernet-security** *new value*

When set to a non-zero value, zeros the padding that is applied to Ethernet packets whose data portion is less than the physical minimum of 60 bytes. This may be required for security reasons. Default: 0.

### **filter-nr**

Allows the NetBIOS “Name Recognized” to be filtered along with the current list of NetBIOS frames filtered by bridge code. NetBIOS Name filters will pass all NetBIOS packets that are not one of the following types: ADD\_GROUP\_NAME\_QUERY, ADD\_NAME\_QUERY, DATAGRAM, NAME\_QUERY. This parameter adds NAME\_RECOGNIZED to the list of types.

### **ip-default-ttl** *#\_of\_packets*

The TTL used in packets that are originated by the device. The default is 64.

**Note:** It is preferable to set this parameter with the **set ttl** IP configuration command. (See the “Set” section of the “Using and Configuring IP” chapter of *Protocol Configuration and Monitoring Reference Volume 1*.) This patch variable remains for compatibility with configurations from older releases.

### **ip-mtu** *bytes*

This parameter limits the IP MTU size to the specified value. When this parameter is set, the IP MTU size on a given network interface is set to the lesser of the ip-mtu value and the largest value that network interface’s configured frame size can accommodate.

### **lnm-link-via-tbport** *new value*

Allows LNM to link to a token-ring over an Ethernet transparent bridge (TB) port.

When set to 1, the LNM link is allowed.

When set to 0, the default, the LNM link is not allowed.

### **more-lines** *#\_of\_lines*

The number of lines to display on the console when listing long output.

### **mosheap-lowmark** *new value*

This parameter specifies the percentage of free MOS heap memory, at which the device notifies the operator that an out-of-memory error is imminent. This notification allows the operator to take action to free up MOS heap memory before the device receives an error and stops.

When the operator receives notification, the operator can reconfigure the device and then reboot, minimizing the outage to the network. Specifying 0 for this parameter suppresses this warning.

**Valid Values:** 0 to 100

## CONFIG Commands

**Default Value:** 10

### **ospf-import-rate** *rate*

Number of routes imported per second.

### **ping-size** *bytes*

The size of the data portion (that is, excluding IP and ICMP headers) of the ICMP PING packet that is sent via the IP>**ping** command. Default: 56 bytes. (The size of the PING data can also be entered as a parameter of the **ping** command as described in the “Ping” section of the “Monitoring IP” chapter of *Protocol Configuration and Monitoring Reference Volume 1*.)

### **ping-ttl** *seconds*

The TTL (time-to-live) sent in PINGs by the IP>**ping** command. Default: 64. (The TTL can also be entered as a parameter of the **ping** command as described in the “Ping” section of the “Monitoring IP” chapter of *Protocol Configuration and Monitoring Reference Volume 1*.)

### **ppp-echo** *new value*

When set to 1, the device will not send PPP Echo Requests on any PPP interface. PPP Echo Requests are sent to remote devices as part of PPP maintenance to ensure the remote device is operational. Consider enabling this variable when running PPP on a slow line and using that line to transmit large data packets such that the PPP maintenance packets are not exchanged often enough to keep the PPP interface up.

### **relax-jate**

Relaxes JATE ISDN restriction.

### **rip-static-suppress** *new value*

When set to a non-zero value, static routes will not be advertised by RIP over a given interface unless the IP config> **enable send static** command is given for the interface. This changes the semantics of the **enable send static** command. When rip-static-suppress is equal to 0 (the default), the list of the routes advertised via RIP is the union of those specified by the interface’s RIP flags.

### **tftp-max-rxto-time**

**tftp-max-rxto-time** allows you to specify the maximum time to wait for a response from the partner before failing the transfer. **Default value:** 5 minutes

The units for this patch variable are seconds.

### **tftp-min-rexmtime**

**tftp-min-rexmtime** allows you to specify the smallest interval of time to wait for a response from the partner before retransmitting the last packet sent.

**Default value:** 1

The units for this patch variable are seconds.

**Note:** You must specify the complete name of the patch variable that you want to change. You cannot use an abbreviated syntax for the patch name.

## Performance

Use the **performance** command at the Config> prompt to enter the configuration environment for performance. See “Chapter 12. Configuring and Monitoring Performance” on page 197 for more information.

### performance



## Protocol

Use the **protocol** command at the Config> prompt to enter the configuration environment for the protocol software installed in the device.

### Syntax:

**protocol** [prot# or prot\_name]

The **protocol** command followed by the desired protocol number *or* short name lets you enter a protocol's command environment. After you enter this command, the prompt of the specified protocol appears. From the prompt, you can enter commands specific to that protocol. To return to Config>, enter the **exit** command.

### Notes:

1. To see the names and numbers of the protocols in your software load, at the Config> prompt, enter **list configuration**.
2. When you change a user-configurable parameter, you may be able to use the protocol's GWCON **reset** command, or you may have to restart the device for the change to take effect. To do so, enter the **reload** command at the OPCON prompt (\*).

The changes you make through CONFIG are kept in a configuration database in nonvolatile memory and are recalled when you restart the device.

## Qconfig

Use the **qconfig** command to initiate Quick Config. Quick Config allows you to configure parameters for bridging and routing protocols without entering separate configuration environments.

### Syntax:

**qconfig**

**Note:** For complete information on using the Quick Config software provided with your device, see "Appendix A. Quick Configuration Reference" on page 755.

## Set

Use the **set** command to configure various system-wide parameters.

### Syntax:

**set** contact-person . . .  
 data-link . . .  
 down-notify . . .  
 dump enable-mode  
 dump save-mode  
 global-buffers  
 hostname  
 inactivity-timer  
 input-low-water  
 location . . .  
 logging level

## CONFIG Commands

packet-size

prompt

receive-buffers

spare-interfaces

### **contact-person** *sysContact*

Sets the name or identification of the contact person for this managed SNMP node. There is a limit of 80 characters for the *sysContact* name length.

This variable is for information purposes only and has no effect on device operation. It is useful for SNMP management identification of the system.

### **data-link** *type interface#*

Select the data link type for a serial interface or a dial circuit interface. The *type* can be one of:

- FRAME-RELAY
- PPP
- SDLC
- SRLY
- V25BIS
- X25

#### **Notes:**

1. PPP, SDLC, and Frame Relay are the only data-links supported on dial circuit interfaces. X.25 is supported on ISDN BRI D-channel only.
2. All data-link types can be used on the 8-port EIA 232E adapter, 6-port V.35/V.36 adapter, and the 8-port X.21 adapter except for V.25 bis which can only be used with the EIA 232E adapter.

*Interface#* is the number of the interface you are configuring.

### **down-notify** *interface# # of seconds*

Allows the user to specify the number of seconds before declaring an interface as being down. The normal maintenance packet interval is 3 seconds, and it takes four maintenance failures to declare the interface as down.

The **set down-notify** command is used primarily when tunneling LLC traffic over an IP network using OSPF. If an interface goes down, OSPF cannot detect it fast enough because of the length of time that it takes for an interface to be declared down. Therefore, LLC sessions would begin to timeout. You can set the down-notify timer to a lower value, allowing OSPF to sense that an interface is down quicker. This enables an alternate route to be chosen more quickly, which will prevent the LLC sessions from timing out.

**Note:** If the **set down-notify** command is executed on one end of a serial link, the same command must be performed at the other end of the link or the link may not come up and stay up.

#### **Interface#**

The number of the interface you are configuring.

#### **# of seconds**

The down notification time value that specifies the maximum time that will elapse before a down interface is marked as such. Large values will cause the device to ignore transient

connection problems, and smaller values will cause the device to react more quickly. The range of values is 1 to 300 seconds and the default is 0, which sets the 3-second period. Setting the down notification time to 0 will restore the default time for that interface.

The **list devices** command will show the down notification time setting for any interface that has the default value overridden.

### dump enable-mode

Specifies whether dumping is enabled following the next system dump. If you configure the save mode (see the **set dump save-mode** command) to save the first three dumps and the system has already created the third dump file, dumping is disabled regardless of your specification. At the time the system creates the third dump file, you will receive the following message:

```
Active Dump Detected.
Dump Compression in Progress, please be patient ...

*** System dumping is being DISABLED because dumping is ***
*** configured to save the 3 initial dumps, but 3         ***
*** dump files already exist.                             ***
```

#### Example:

```
Config> set dump enable-mode

Current System Dump Settings:
  Disable System Dump following the next system dump.
  Save the last 3 (most recent) dump files.

Do you want to change system dump enable-mode to
re-enable System Dump following the next system dump ? (Yes, No): [No] Yes

Current System Dump Settings:
  Re-enable System Dump following the next system dump.
  Save the last 3 (most recent) dump files.

Current System Dump Status:
  System dump is currently enabled.
  Number of existing dump files: 2
```

**Default value:** disable

**Note:** Dumping is enabled with the **enable dump-memory** command.

### dump save-mode

Specifies whether to save the first three (initial) system dump files or the last three (most recent). See the **dump enable-mode** for a consideration for using recent mode as opposed to initial mode.

#### Example:

```
Config> set dump save-mode

Current System Dump Settings:
  Re-enable System Dump following the next system dump.
  Save the last 3 (most recent) dump files.

Do you want to change system dump save-mode to
save the first (initial) dump files ? (Yes, No): [No] Yes

Current System Dump Settings:
  Re-enable System Dump following the next system dump.
  Save the first 3 (initial) dump files, then disable system dump.

Current System Dump Status:
  System dump is currently enabled.
  Number of existing dump files: 2
```

## CONFIG Commands

**Default value:** recent

### **global-buffers** *max#*

Sets the maximum number of global packet buffers, which are the packet buffers used for locally originated packets. The default is to autoconfigure for the maximum number of buffers (up to 10000). To restore the default, set the value to 0. To display the setting for global-buffers, use the **list configuration** command.

### **hostname** *name*

Adds or changes the device name. The device name is for identification only; it does not affect any device addresses. The *name* must be less than 78 characters and is case sensitive.

### **inactivity-timer** *#\_of\_min*

Changes the setting of the Inactivity Timer. The Inactivity Timer logs out a user if the remote or physical console is inactive for the period of time specified in this command. This command affects only consoles that require login. The default setting of 0 turns the inactivity timer off, indicating that no logoff is performed, no matter how long a console remains inactive.

### **input-low-water** *interface# low\_ #\_of\_receive\_buffers*

Allows you to configure an interface's low threshold for receive buffers. When the current number of receive buffers for an interface is less than the interface's low threshold, the packet is eligible for flow control (dropping) if the packet is queued on an output queue that has reached its high threshold (fair) value. See the description of the GWCON **queue** command for more details on flow control.

Lowering the low threshold value will make it less likely that packets from this interface will be dropped when sent on congested networks. However, lowering the value may negatively affect performance if underruns occur because the receive buffer queue is empty. Raising the value has the opposite effect. To determine if underruns are occurring, use the GWCON **interface** command and specify the interface number. To determine if packets from this interface are being dropped because the low threshold has been reached, use the GWCON (Talk 5) **error** command and look at the Input Flow Drop counter value for the interface.

The range of values is 1 to 255. The default is both product-specific and device-specific. The low threshold should be less than the requested number of receive buffers. Specifying a value of 0 restores the autoconfigured default.

Use the GWCON (Talk 5) **buffer** and **queue** commands to show the low threshold setting.

*Interface#* is the number of the interface you are configuring.  
*Low\_#\_of\_receive\_buffers* is the low threshold value.

### **location** *sysLocation*

Sets the physical location of an SNMP node. There is a limit of 80 characters for the *sysLocation* name length. This variable is for information purposes only and has no effect on device operation. It is useful for SNMP management identification of the system.

### **logging level** *#*

Controls the output of messages that have not yet been converted to the ELS. (Refer to for more information about the ELS.) The logging level is recorded in the configuration. When the device is powered on or restarted,

the logging level takes effect and determines message output. The default logging level is 76. Logging level 0 equates to no logging level.

Example: `set logging level 76`

**packet-size** *max\_packet\_size\_in\_bytes*

Establishes or changes the maximum size for global buffers and receive buffers. If you specify a value of 0 as the maximum packet size, the size of receive buffers for an interface is based on that interface’s configured packet size and the packet size of global buffers are autoconfigured. If you specify a non-zero value, the configured value is used as the global buffer packet size and any interfaces that have a configured packet size that is larger than the maximum packet size will use the maximum packet size for their receive buffers. A value of 0 (for autoconfigure) is the default.

**Attention:** Use this command only under direct instructions from your service representative. **Never** use it to reduce packet size – **only** to increase it.

**prompt** *user-defined-name*

Adds a user-defined name as a prefix to all operator prompts, replacing the hostname.

The user-defined-name can be any combination of characters, numbers, and spaces up to 80 characters. Special characters may be used to request additional functions as described in Table 10.

**Example:**

```
set prompt
What is the new MOS prompt [y]? AnyHost 99
AnyHost 99 Config>
```

Table 10. Additional Functions Provided by the Set Prompt Level Command

Special Characters	Function Provided by the Set Prompt Level Command
\$n	Displays the hostname. This is useful when you want the hostname included in the prompt. For example: Config> <b>set prompt</b> What is the new MOS prompt [y]? \$n hostname:: Config>
\$t	Displays the time. For example: Config> <b>set prompt</b> . What is the new MOS prompt [y]? \$t 02:51:08[GMT-300] Config>
\$d	Displays the current date-month-year. For example: Config> <b>set prompt</b> . What is the new MOS prompt [y]? \$d 26-Feb-1997 Config>
\$v	Displays the software VPD information in the following format: program-product-name Feature xxxx Vx Rx.x PTFx RPQx
\$e	Erases one character <i>after</i> this combination within the user-defined prompt.
\$h	Erases one character <i>before</i> this combination within the user-defined prompt.
\$_	Adds a carriage return to the user-defined prompt.
\$\$	Displays the \$.

## CONFIG Commands

Table 10. Additional Functions Provided by the Set Prompt Level Command (continued)

Special Characters	Function Provided by the Set Prompt Level Command
<b>Note:</b> You can combine these commands. For example:	
<pre>Config&gt; set prompt What is the new MOS prompt [y]? \$n::\$d hostname::26-Feb-1997 Config&gt;</pre>	

### **receive-buffers** *interface# max#*

Adjusts the number of private receive buffers for most interfaces to increase the receive performance of an interface and to reduce flow control drops when the router is forwarding many packets from a fast interface to a slow interface. The range of values is 5 to 4096. To restore the default, specify a value of 0. Not all device types allow the maximum number of receive buffers to be configured or support up to 4096 receive buffers. Use Table 11 to determine the default and maximum values for each device type. This command does not enforce the maximum values shown in Table 11. It allows you to configure a maximum value that is not supported by a device.

The effect of this command is shown by the GWCON **buffer** command. If you configure a valid maximum value, this value appears in the Input Req column of the GWCON buffer command output. If you configure a maximum value that is not supported by the device, the GWCON **buffer** command shows the default number of receive buffers in the Input Req column and a GW subsystem ELS message is logged.

**Note:** This command is not applicable for ISDN Primary Rate Interfaces. For ISDN PRI, the number of receive buffers is fixed at 5 per B-channel, 115 for T1 and 150 for E1. When in channelized mode, the PRI gets 5 receive buffers per configured timeslot.

Table 11. Default and Maximum Settings for Interfaces

Interface	Default	Maximum
ATM	80*	4096 **
10 Mbps Ethernet	40*	1000
10/100 Mbps Ethernet	64*	1000
Serial	24	250
TKR	40*	1000
FDDI	80	80
HSSI	60*	1000
ESCON	1000	1000
PCA	1000	1000

\* This is the default value for the 2216-400. For Network Utility, the default value is 1000

**\*\*Important:** Increase this value very carefully. A range of 80 to 120 receive-buffers results in the best performance of a limited number of ATM connections measured by packets per second of throughput. Setting this value too large for routers with limited system memory may prevent the router from booting and operating properly. For example, a router with 64 MB of memory will not run with 4 KB of buffers configured.

**spare-interfaces *n***

Defines *n*, the number of spare interfaces, for this device. See “Configuring Spare Interfaces” on page 66 for additional information.

## System Retrieve

Use the **system retrieve** command to retrieve one or more memory image files from the installed hard drive after a serious error has occurred.

**Syntax:**

```
system                retrieve
```

Uses TFTP to send selected memory image files to a remote host. The system will prompt you for the remote host's IP address and file names.

If there are no dump files, you will receive the following message:

```
No dump files exist to retrieve
```

**Example:**

```
Config> system retrieve
```

```
Current System Dump Settings:
```

```
  Re-enable System Dump following the next system dump.
```

```
  Save the first 3 (initial) dump files, then disable system dump.
```

```
3 dump files currently exist.
```

```
Do you want to see a summary of the dump files ? (Yes, No): [No] No
```

```
Destination IP address [0.0.0.0]? 9.9.9.1
```

```
Filename: core0.cmp
```

```
Dump Date: Tue May 05 14:38:59 1998
```

```
Do you want to retrieve this file ? (Yes, No): [No] Yes
```

```
Fully qualified destination path/file name [/tmp/dump0.cmp]?
```

```
The memory image file is 19.3 Mb long.
```

```
Proceed? [No]: Yes
```

```
Sending memory image file by tftp
```

```
TFTP transfer of /hd0/core0.cmp complete, size=20331888 status: OK
```

```
tftp transfer completed successfully.
```

```
Filename: core1.cmp
```

```
Dump Date: Wed May 06 07:53:51 1998
```

```
Do you want to retrieve this file ? (Yes, No): [No]
```

```
Filename: core2.cmp
```

```
Dump Date: Wed May 06 09:14:55 1998
```

```
Do you want to retrieve this file ? (Yes, No): [No]
```

## System View

Use the **system view** command to display the current system dump settings and the status of the system dumps, including how many dump files exist. You can also display a summary of the dump files.

**Syntax:**

```
system                view
```

**Example:**

## CONFIG Commands

```
Config> system view

Current System Dump Settings:
  Re-enable System Dump following the next system dump.
  Save the first 3 (initial) dump files, then disable system dump.

Current System Dump Status:
  System dump is currently enabled.
  Number of existing dump files: 2

Do you want to see a summary of the dump files ? (Yes, No): [No] Yes
-----
Filename: core0.cmp

Dump Date: Tue May 05 14:38:59 1998

Fatal messages:
  Data St. Excp Reading 0x6c6966b1 at 0x3090fca4 in thread MOSDBG (0x304d54)

CMVC Build: cc_144b
Builder: build
Build Name: LML.1d
Retain Name: MAS.DF1
Product Number: 2216-MAS
Build Date: Wed May 6 11:47:03 1998

-----
Filename: core1.cmp

Dump Date: Wed May 06 07:53:51 1998

Fatal messages:
  Data St. Excp Reading 0x6c6966b1 at 0x3090fca4 in thread MOSDBG (0x304d54)

CMVC Build: cc_144b
Builder: build
Build Name: LML.1d
Retain Name: MAS.DF1
Product Number: 2216-MAS
Build Date: Wed May 6 11:47:03 1998
```

## Time

Use the **time** command to set the 2216 system clock and date, and to display the values on the user console. These values can then be used to time-stamp ELS messages.

**Note:** The 2216 has a hardware clock that maintains the date and time after device reinitialization.

### Syntax:

```
time                host . . .
                    list
                    offset
                    set . . .
                    source-address . . .
                    sync . . .
```



**host** *IP\_address*

Sets the IP address of the RFC 868-compliant host that will be used as the time source. This is the address of a host which will respond to an empty datagram on UDP port 37 with a datagram containing the current time.

**list** Displays all configured time-related parameters. This includes the current time (if set) and the source of the time (operator or IP address from which time was last received).

```
Example: time list
05:20:27 Wednesday December 7, 1994
Set by: operator
Time Host: 131.210.4.1
Sync Interval: 10 seconds GMT
Offset: -300 minutes
```

**offset** *minutes*

Defines the time zone, in minutes, offset from GMT (Greenwich Mean Time). Note that values west of GMT are negative. For example, EST is 5 hours earlier than GMT, so the command would be **time offset -300**.

**Valid values:** -720 to 720

**Default value:** 0

**set** *<year month date hour minute second>*

Prompts you to set the current time. If you do not specify the entire time in the command, you are prompted for the remaining values. You can change the date as shown in the following example.

```
Example: time set
year [1996] 1997
month [12]?
date [6]? 7
hour [11]? 12
minute [3]?
second [2]?
```

**source-address** *IP\_address*

Sets the UDP source IP address of the time server data packets.

**sync** *seconds*

Sets the period, in seconds, at which the device will poll the time host for the current time.

## Unpatch

Use the **unpatch** command to restore the values of the patch variables entered with the **patch** command to their default values. See the **patch** command in “Patch” on page 96 for details.

**Syntax:**

**unpatch** *variable\_name*

**Note:** You **must** specify the complete name of the patch variable to be restored.

## Update

Use the **update** command to update the configuration memory when you receive a new software load.

**Syntax:**

**update** *\_version-of-SRAM*

## CONFIG Commands

Follow the instructions on the release notice sent with the software. The **update** command is the last command that you enter when loading new software. After you enter this command, the console displays a message indicating configuration memory is being updated.

## Write

Use the **write** command to save a configuration to the device before reloading.

### Syntax:

#### write

If you fail to issue the **write** command and try to reload the device, you will be asked if you want to save the configuration. The configuration is saved in the next CONFIG on the hard disk in the bank you are currently using.

---

## Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands

This chapter describes the GWCON process and includes the following sections:

- “What is GWCON?”
- “Entering and Exiting GWCON”
- “GWCON Commands”

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### What is GWCON?

The Gateway Console (monitoring) process, GWCON (also referred to as CGWCON), is a second-level process of the device user interface.

Using GWCON commands, you can:

- List the protocols and interfaces currently configured in the device.
- Display memory and network statistics.
- Set current Event Logging System (ELS) parameters.
- Test a specified network interface.
- Communicate with third-level processes, including protocol environments.
- Enable and disable interfaces.

The GWCON command interface is made up of levels called modes. Each mode has its own prompt. For example, the prompt for the SNMP protocol is `SNMP>`.

If you want to know the process and mode you are communicating with, press **enter** to display the prompt. Some commands in this chapter, such as the **network** and **protocol** commands, allow you to access the various modes in GWCON.

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### Entering and Exiting GWCON

To enter GWCON from OPCON (\*), choose one of the following methods:

1. Enter the OPCON **console** command:  
\* `console`
2. At the OPCON prompt, enter the **status** command to find the PID of GWCON. (See page 9 for a sample output of the **status** command.)  
\* `status`

Then, enter the **talk** command followed by the PID number for GWCON:

\* `talk 5`

The console displays the GWCON prompt (+). If the prompt does not appear, press **enter**. Now you can enter GWCON commands.

To return to OPCON, enter the OPCON intercept character. (The default is **Ctrl-P**.)

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### GWCON Commands

This section contains the GWCON commands. Each command includes a description, syntax requirements, and an example. The GWCON commands are summarized in Table 12 on page 110.

To use the GWCON commands, access the GWCON process by entering **talk 5** and enter the GWCON commands at the (+) prompt.

## GWCON Commands

Table 12. GWCON Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Activate	Enables a newly configured spare interface.
Buffer	Displays information about packet buffers assigned to each interface.
Clear	Clears network statistics.
Configuration	Lists status of the current protocols and interfaces.
Disable	Takes the specified interface or slot off line.
Disk	Lists, retrieves, and deletes service-related files.
Enable	Enables all interfaces.
Error	Displays error counts.
Event	Enters the Event Logging System environment.
Feature	Provides access to console commands for independent device features outside the usual protocol and network interface console processes.
Interface	Displays network hardware statistics or statistics for the specified interface.
Memory	Displays memory, buffer, and packet data.
Network	Enters the console environment of the specified network.
Performance	Provides a snapshot of the main processor utilization statistics.
Protocol	Enters the command environment of the specified protocol.
Queue	Displays buffer statistics for a specified interface.
Reset	Disables the specified interface and then re-enables it using new interface, protocol and feature configuration parameters.
Statistics	Displays statistics for a specified interface.
Test	Enables a disabled interface or tests the specified interface.
Uptime	Displays time statistics for the device.

### Activate

Use the **activate** command to enable a spare interface on this device. See "Configuring Spare Interfaces" on page 66 for more information.

**Syntax:**

**activate** *interface#*

### Buffer

Use the **buffer** command to display information about packet buffers assigned to each interface or range of interfaces.

**Note:** Each buffer on a device is the same size and is dynamically built. Buffers vary in size from one device to another.

To display information about one interface only, enter the interface or network number as part of the command. To obtain the interface number, use the GWCON **configuration** command.

**Syntax:**

**buffer** [*network# or range\_of\_network#*]

To display information about multiple interfaces, specify the *range\_of\_network#* (or a combination of *network#* and *range\_of\_network#*). For example, specifying **buffer 0 3 25-50** displays the information for nets 0, 3, and 25 through 50.

**Example:**

**buffer**

Nt	Interface	Input Buffers:				Buffer sizes:					
		Req	Alloc	Low	Curr	Hdr	Wrap	Data	Trail	Total	Bytes Alloc
0	TKR/0	20	20	7	0	109	92	2052	7	2260	45200
1	PPP/0	20	20	7	20	109	92	2052	7	2260	45200
2	PPP/1	10	10	4	0	108	92	2048	0	2248	22480

**Nt** Network interface number associated with the software.

**Interface**

Type of interface.

**Input Buffers:**

**Req** Number of receive buffers requested. This is either the device's default number of receive buffers or a valid value set with the CONFIG (Talk 6) **set receive-buffers** command.

**Notes:**

1. If this column is 0 for an interface, then this is a virtual interface for which receive buffers are not allocated. In this case, the virtual interface uses the receive buffers of the device that it is mapped to. For example, a dial circuit interface uses the receive buffers of its base net or interface.
2. If you specify a value on the CONFIG **set receive-buffers** command that is not supported by the device, then the number of buffers requested is equal to the device's default number of receive buffers.

**Alloc** Number of receive buffers allocated.

**Note:** The number of receive buffers allocated is less than the number of receive buffers requested if there is not enough memory available to allocate the requested number of buffers.

**Low** The device's low threshold for receive buffers. When the current number of receive (input) buffers for an interface is less than the interface's low threshold, the packet is eligible for flow control (dropping). See the description of the GWCON (Talk 5) **queue** command for more details on flow control. The low threshold is configurable using the CONFIG (Talk 6) **set input-low-water** command.

**Curr** Current number of buffers on this device. The value will be 0 if the device is disabled. When a packet is received, if the value of *Curr* is below *Low*, then the packet is eligible for flow control. (See the **queue** command for conditions.)

**Buffer Sizes:**

**Hdr** Sum of the maximum hardware, MAC, and data link headers.

**Wrap** Allowance given for MAC, LLC, or Network layer headers due to protocol wrapping.

**Data** Maximum data link layer packet size.

**Trail** Sum of the largest MAC and hardware trailers.

**Total** Overall size of each packet buffer.

## GWCON Commands

### Bytes Alloc

Amount of buffer memory for this device. This value is determined by multiplying the values of *Alloc x Total*.

## Clear

Use the **clear** command to delete statistical information about one or all of the device's network interfaces. This command is useful when tracking changes in large counters. Using this command does not save space or speed up the device.

Enter the interface (or net) number as part of the command. To get the interface number, use the GWCON **configuration** command.

### Syntax:

**clear** *interface# or range\_of\_interface#*

To clear information about multiple interfaces, specify the *range\_of\_network#* (or a combination of *interface#* and *range\_of\_interface#*). For example, specifying **clear 0 3 25-50** clears the information for nets 0, 3, and 25 through 50.

## Configuration

Use the **configuration** command to display information about the protocols and network interfaces. The output is displayed in three sections, the first section lists the device identification, software version, boot ROM version, and the state of the auto-boot switch. The second and third sections list the protocol and interface information.

### Syntax:

**configuration**

To display information about multiple interfaces, specify the *range\_of\_network#* (or a combination of *network#* and *range\_of\_network#*). For example, specifying **configuration 0 3 25-50** displays the information for nets 0, 3, and 25 through 50.

### Example:

**configuration**

Multiprotocol Access Services

2216-MAS Feature 2822 V3.2 Mod 0 PTF 0 RPQ 0 MAS.EF9 cc4\_2a

Num	Name	Protocol
0	IP	DOD-IP
3	ARP	Address Resolution
4	DN	DNA Phase IV
6	VIN	Banyan Vines
7	IPX	NetWare IPX
10	BGP	Border Gateway Protocol
11	SNMP	Simple Network Management Protocol
12	OSPF	Open SPF-Based Routing Protocol
22	AP2	AppleTalk Phase 2
23	ASRT	Adaptive Source Routing Transparent Enhanced Bridge
26	DLS	Data Link Switching
27	XTP	X.25 Transport Protocol
28	APPN	Advanced Peer-to-Peer Networking [HPR]
30	APPN	Advanced Peer-to-Peer Networking [ISR]

Num	Name	Feature
2	MCF	MAC Filtering

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Net	Interface	MAC/Data-Link	Hardware	State
0	TKR/0	Token-Ring/802.5	Token-Ring	Up
1	TKR/1	Token-Ring/802.5	Token-Ring	Up
2	TKR/2	Token-Ring/802.5	Token-Ring	Up
3	TKR/3	Token-Ring/802.5	Token-Ring	Up
4	Eth/0	Ethernet/IEEE 802.3	Ethernet	Up
5	Eth/1	Ethernet/IEEE 802.3	Ethernet	Up
6	Eth/2	Ethernet/IEEE 802.3	Ethernet	Up
7	Eth/3	Ethernet/IEEE 802.3	Ethernet	Up
8	Eth/4	Ethernet/IEEE 802.3	Ethernet	Up
9	Eth/5	Ethernet/IEEE 802.3	Ethernet	Up
10	FR/0	Frame Relay	V.35/V.36	Up
11	X25/0	X.25	V.35/V.36	Up
12	PPP/0	Point to Point	V.35/V.36	Up
13	PPP/1	Point to Point	V.35/V.36	Up
14	PPP/2	Point to Point	V.35/V.36	Up
15	PPP/3	Point to Point	V.35/V.36	Up

- The first line gives the product name.
- The second line lists the program/product number, Feature Number, Version, Release, PTF and RPQ information.
- The remaining lines list the configured protocols, followed by the configured features.

The following information is displayed for protocols:

**Num** Number that is associated with the protocol.

**Name** Abbreviated name of the protocol.

**Protocol**

Full name of the protocol.

The following information is displayed for features:

**Num** Number associated with the feature.

**Name** Abbreviated name of the feature.

**Feature**

Full name of the feature.

The following information is displayed for networks:

**Net** Network number that the software assigns to the interface. Networks are numbered starting at 0. These numbers correspond to the interface numbers discussed under the CONFIG process.

**Interface**

Name of the interface and instance of this type of interface.

**MAC/Data Link**

Type of MAC/Data link configured for the interface.

**Hardware**

Specific kind of interface by hardware type.

**State** Current state of the network interface.

**Testing**

Indicates that the interface is undergoing a self-test. Occurs when the device is first started, when a problem is detected on the interface, or when the **test command** is used. (The **enable slot** command can also be used to initiate a self-test of all interfaces on an adapter.)

When an interface is operational, the interface periodically sends out maintenance packets and/or checks the physical state of the

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port or line to ensure that the interface is still functioning correctly. If the maintenance fails, the interface is declared down and a self-test is scheduled to run in 5 seconds. If a self-test fails, the interface transitions to the down state and the interval until the next self-test is increased up to a maximum of 2 minutes. If the self-test is successful, the network is declared up.

**Up** Indicates the interface is operational.

**Down** Indicates that the interface is not operational and has failed a self-test. The network will periodically transition to the testing state to determine if the interface can become operational again.

### Disabled

Indicates that the interface is disabled. An interface can be disabled by the following methods:

- An interface can be configured as disabled using the CONFIG **disable** command. Each time the device is reinitialized, the interface's initial state will be disabled. It will remain in the disabled state until an action is taken to enable it.
- An interface can be disabled using the GWCON **disable** command. This method is temporary because the interface will revert to its configured state (enabled or disabled) when the device is reinitialized.
- The network manager can disable the interface through SNMP. This method is temporary because the interface will revert to its configured state (enabled or disabled) when the device is reinitialized.

When an interface is disabled, it remains disabled until one of the following methods is used to enable it:

- The GWCON **test** command is used to start a self-test of the interface.
- The GWCON **enable slot** command is used to start a self-test on all interfaces on an adapter.
- The network manager initiates a self-test of the interface through SNMP.

WAN Reroute also can change the state of a disabled interface. If an interface is configured as an alternate interface for WAN Reroute and its configured state is disabled, WAN Reroute will start a self-test of the interface when the primary interface goes down. When the primary interface is operational and stable again, WAN Reroute puts the alternate interface back to its configured state. Refer to The WAN Reroute Feature in *Using and Configuring Features* for more information.

### Available

Indicates that the interface has been configured as a secondary WAN Restoral interface and it is available to back up the primary interface.

### Not Present

Indicates that the interface's adapter is not plugged in.

Not Present is also used as the state for a null device. Spare interfaces are displayed as null devices until they are activated.



**HW Mismatch**

Indicates that the configured adapter type does not match the adapter type that is actually present in the slot.

**HW Failure**

Indicates that there is an unrecoverable hardware error for the interface's hardware.

**Diagnostics**

Indicates that hardware diagnostics are running.

**Disable**

Use the **disable** command to take a network interface or slot off-line, making the interface or slot unavailable. This command immediately disables the interface or slot. You are not prompted to confirm, and no verification message displays. If you disable an interface or slot with this command, it remains disabled until you use the GWCON **test** command or an OPCON **reload** command to enable it.

Enter the interface or net number or slot as part of the command. To obtain the interface number or slot number, use the GWCON **configuration** command.

**Note:** If the interface you are disabling is configured as an alternate WAN Reroute interface, you are asked if you want to disable any WAN Reroute primary/alternate pairings that include this alternate interface. If you answer *yes*, the interface is disabled and is no longer available to backup a primary interface. If you answer *no*, the alternate interface is disabled but WAN Reroute will attempt to bring it up if its corresponding primary interface goes down. You want to disable WAN Reroute on an alternate interface if you are disabling the interface so that you can remove its adapter. See The WAN Reroute Feature, Using WAN Restoral, and Configuring and Monitoring WAN Restoral in the *Using and Configuring Features* for additional information.

**Syntax:**

```
disable                _interface interface#
                        _slot slot#
```

**Disk**

Use the **disk** command to list, retrieve, or delete service-related files from the hard disk. The following categories of files can be listed, retrieved, or deleted: APPN, Adapter, ELS, SYSTEM or other (other files are ones that do not fit into another category). Only files that are actually located are listed. The following information is provided for the files that are located: name, comment that tells what the file is, size of the file, and the date that the file was created. For the system dump files, additional information is given about the dump. When retrieving or deleting a file, you are prompted to confirm the command. For retrieving a file, you will also need to provide the destination IP address that defines where the file should be sent and the name to be given to the file when it is written.

**Syntax:**

```
disk                  _list category
                        _retrieve category
                        _delete category
```

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The categories are: adapter, appn, els, other, and system.

### Example:

```
+disk list system
'core' Master System dump file (uncompressed)
Size: 268435456 bytes Date: Tues Apr 06 10:054:30 1999
'core0.cmp' System dump file (compressed)
Size: 11208443 bytes Date: Tues Apr 06 10:15:28 1999
'core1.cmp' System dump file (compressed)
Size: 11150344 bytes Date: Tues Apr 06 10:54:30 1999
There are 3 different files
Do you want to see the details of the compressed dumps? [No]: n
```

## Enable

Use the **Enable** command to enable all interfaces of an adapter. This performs the same action as the **test** command (see “Test” on page 123) but performs the action for each interface using the adapter in the specified slot.

### Syntax:

**enable** slot *slot#*

## Error

Use the **error** command to display error statistics for the network. This command provides a group of error counters.

### Syntax:

**error** [*network# or range\_of\_network#*]

To display information about multiple interfaces, specify the *range\_of\_network#* (or a combination of *network#* and *range\_of\_network#*). For example, specifying **error 0 3 25-50** displays the information for nets 0, 3, and 25 through 50.

### Example:

```
error
```

Nt	Interface	Input Discards	Input Errors	Input Unk Proto	Input Flow Drop	Output Discards	Output Errors
0	TKR/0	0	0	0	0	0	0
1	PPP/0	0	0	0	0	0	0
2	PPP/1	0	0	0	0	0	0

**Nt** Network interface number associated with the software.

### Interface

Type of interface.

### Input Discards

Number of inbound packets which were discarded even though no errors were detected to prevent their being deliverable to a higher-layer protocol. The packets may have been discarded to free buffer space.

### Input Errors

Number of packets that were found to be defective at the data link.

### Input Unk Proto

Number of packets received for an unknown protocol.

### Input Flow Drop

Number of packets received that are flow controlled on output.

**Output Discards**

Number of packets that the device chose to discard rather than transmit due to flow control.

**Output Errors**

Number of output errors, such as attempts to send over a network that is down or over a network that went down during transmission.

**Note:** The sum of the discarded output packets is not the same as input flow drops over all networks. Discarded output may indicate locally originated packets.

## Event

Use the **event** command to access the Event Logging System (ELS) console environment. This environment is used to set up temporary message filters for troubleshooting purposes. All changes made in the ELS console environment will take effect immediately, but will go away when the device is reinitialized. See “Chapter 10. Using the Event Logging System (ELS)” on page 127 for information about the Event Logging System and its commands. Use the **exit** command to return to the GWCON process.

**Syntax:**

event

## Feature

Use the **feature** command to access console commands for specific 2216 features outside of the protocol and network interface console processes.

Enter a question mark after the **feature** command to obtain a listing of the features available for your software release.

To access that feature’s console prompt, enter the **feature** command at the GWCON prompt followed by the feature number or short name. Table 9 on page 91 lists available feature numbers and names.

Once you access the prompt for that feature, you can begin entering specific commands to monitor that feature. To return to the GWCON prompt, enter the **exit** command at the feature’s console prompt.

**Syntax:**

feature *feature# or feature-short-name*

## Interface

Use the **interface** command to display statistical information about the network interfaces (for example, Ethernet). This command can be used without a qualifier to provide a summary of all the interfaces or with a qualifier to reveal detailed information about one specific interface.

Descriptions of detailed output for each type of interface are provided in the specific interface *Monitoring* chapters found in this guide. To obtain the interface number, use the GWCON **configuration** command.

**Syntax:**

interface *[interface# or range\_of\_interface#]*

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To display information about multiple interfaces, specify the *range\_of\_network#* (or a combination of *interface#* and *range\_of\_interface#*). For example, specifying **interface 0 3 25-50** displays the information for nets 0, 3, and 25 through 50.

### Example: interface

Nt	Nt'	Interface	Slot-Port		Self-Test Passed	Self-Test Failed	Maintenance Failed
0	0	TKR/0	Slot: 1	Port: 1	1	0	0
1	1	TKR/1	Slot: 1	Port: 2	2	1	0
2	2	TKR/2	Slot: 2	Port: 1	2	1	0
3	3	TKR/3	Slot: 2	Port: 2	2	1	0
4	4	Eth/0	Slot: 4	Port: 1	1	0	0
5	5	Eth/1	Slot: 4	Port: 2	1	0	0
6	6	Eth/2	Slot: 5	Port: 1	1	0	0
7	7	Eth/3	Slot: 5	Port: 2	3	2	2
8	8	Eth/4	Slot: 6	Port: 1	1	0	0
9	9	Eth/5	Slot: 6	Port: 2	5	4	1
10	10	FR/0	Slot: 8	Port: 0	2	1	0
11	11	X25/0	Slot: 8	Port: 1	1	0	0
12	12	PPP/0	Slot: 8	Port: 2	2	1	0
13	13	PPP/1	Slot: 8	Port: 3	1	0	0
14	14	PPP/2	Slot: 8	Port: 4	1	0	0
15	15	PPP/3	Slot: 8	Port: 5	1	0	0

**Note:** The following information may be displayed. The display varies depending on the device.

**Nt** Global interface number.

**Nt'** Reserved for dial circuit use. Interface number of the physical network interface that the dial circuit uses.

### Interface

Interface name.

### Slot-Port

Slot number and port number of the interface.

### Self-Test Passed

Number of times self-test succeeded (state of interface changes from down to up).

### Self-Test Failed

Number of times self-test failed (state of interface changes from up to down).

### Maintenance Failed

Number of maintenance failures.

## Memory

Use the **memory** command to display the current CPU memory usage in bytes, the number of buffers, and the packet sizes.

To use this command, free memory must be available. The number of free packet buffers may drop to zero, resulting in the loss of some incoming packets; however, this does not adversely affect device operations. The number of free buffers should remain constant when the device is idle. If it does not, contact your service representative.

### Syntax:

**memory**

### Example:

**memory**

Physical installed memory: 16 MB  
 Total routing (heap) memory: 12 MB  
 Routing memory in use: 13 %

	Total	Reserve	Never Alloc	Perm Alloc	Temp Alloc	Prev Alloc
Heap memory	12231155	26488	10687312	1438487	104924	432

Number of global buffers: Total = 300, Free = 300, Fair = 77, Low = 60  
 Global buff size: Data = 2048, Hdr = 17, Wrap = 72, Trail = 65, Total = 2208

**Physical installed memory**

The total amount of physical RAM installed in the device.

**Total routing memory**

The amount of memory available to the routing function, not including that allocated to the base operating system, system extensions, or options such as APPN. This is also called "heap" memory, and matches the "Total" heap memory size given in bytes shortly thereafter.

**Routing memory in use**

The percentage of total routing memory that is currently being used by the routing function. Heap memory currently in use is counted under the following headings **Perm Alloc** and **Temp Alloc**.

**Heap memory:**

Amount of memory used to dynamically allocate data structures.

**Total** Total amount of space available for allocation for memory.

**Reserve**

Minimum amount of memory needed by the currently configured protocols and features.

**Never Alloc**

Memory that has never been allocated.

**Perm Alloc**

Memory requested permanently by device tasks.

**Temp Alloc**

Memory allocated temporarily to device tasks.

**Prev Alloc**

Memory allocated temporarily and returned.

Number of global buffers:

**Total** Total number of global buffers in the system.

**Free** Number of global buffers available.

**Fair** Fair number of buffers for each interface. (See "Low".)

**Low** The number of free buffers at which the allocation strategy changes to conserve buffers. If the value of *Free* is less than *Low*, then buffers will not be placed on any queue that has more than the *Fair* number of buffers in it.

**Global buff size:**

Global buffer size.

**Data** Maximum data link packet size of any interface.

**Header**

Sum of the maximum hardware, MAC, and data link headers.

**Wrap** Allowance given for MAC, LLC, or Network layer headers due to protocol wrapping.

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**Trailer** Sum of the largest MAC and hardware trailers.

**Total** Overall size of each packet buffer

## Network

Use the **network** command to enter the console environment for supported networks, such as X.25 networks. This command obtains the console prompt for the specified interface. From the prompt, you can display statistical information, such as the routing information fields for Token-Ring networks.

### Syntax:

**network** *interface#*

At the GWCON prompt (+), enter the **configuration** command to see the protocols and networks for which the device is configured. See “Configuration” on page 112 for more information on the configuration command.

Enter **interface** at the + prompt for a display of the networks for which the device is configured.

Enter the GWCON **network** command and the number of the interface you want to monitor or change. For example:

```
+network 3  
X.25>
```

In the example, the X.25> prompt is displayed. You can then view information about the X.25 interface by entering the X.25 operating commands.

After identifying the interface number of the interface you want to monitor, for interface-specific information, see the corresponding monitoring chapter in this manual for the specified network or link-layer interface. Console support is offered for the following network and link-layer interfaces:

- Ethernet
- Frame Relay
- PPP
- SDLC
- SDLC Relay (SRLY)
- Token-Ring
- V.25 bis
- X.25
- ATM
- ISDN
- Dial-In
- Multilink PPP (MP)
- Layer-2-Tunneling

## Performance

Use the **performance** command at the GWCON prompt to enter the monitoring environment for performance. See “Chapter 12. Configuring and Monitoring Performance” on page 197 for more information.

## Protocol

Use the **protocol** command to communicate with the device software that implements the network protocols installed in your device. The **protocol** command

accesses a protocol's command environment. After you enter this command, the prompt of the specified protocol appears. From the prompt, you can enter commands that are specific to that protocol.

**Syntax:**

**protocol** *prot#*

Enter the protocol number or short name as part of the command. To obtain the protocol number or short name, enter the CONFIG command environment (Config>), and then enter the **list configuration** command. See "Accessing the Configuration Process, CONFIG (Talk 6)" on page 13 for instructions on accessing Config>. To return to GWCON, enter **exit**.

See the corresponding monitoring chapter in this manual or in the *Protocol Configuration and Monitoring Reference* for information on a specific protocol's console commands.

## Queue

Use the **queue** command to display statistics about the length of input and output queues on the specified interfaces. Information about input and output queues provided by the queue command includes:

- The total number of buffers allocated
- The low-level buffer value
- The number of buffers currently active on the interface.

**Syntax:**

**queue** *interface# or range\_of\_interface#*

To display information about multiple interfaces, specify the *range\_of\_network#* (or a combination of *interface#* and *range\_of\_interface#*). For example, specifying **queue 0 3 25-50** displays the information for nets 0, 3, and 25 through 50.

To display information about one interface only, enter the interface or network number as part of the command. To obtain the interface number, use the GWCON **configuration** command.

**Example:**

```
queue
      Input Queue      Output Queue
Nt Interface Alloc Low Curr Fair Curr
0 Eth/0      30 10 30      30 1
1 PPP/0      24 4 24       4 0
2 FR/0       24 4 24       5 0
```

**Nt** Network interface number associated with the software.

**Interface**

Type of interface.

**Input Queue:**

**Alloc** Number of buffers allocated to this device.

**Low** The low threshold for receive (input) buffers is used to activate flow control for this device. The low threshold is configurable using the CONFIG (Talk 6) **set input-low-water** command.

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**Curr** Current number of buffers on this device. The value will be 0 if the device is disabled.

**Output Queue:**

**Fair** The high threshold for the interface's output queue when flow control is activated for an input device.

**Note:** When Bandwidth Reservation (BRS) is configured for PPP and Frame Relay interfaces, the output fair value is ignored and the queue lengths configurable with BRS are used to determine if a packet should be discarded due to flow control.

**Curr** Number of packets currently waiting to be transmitted on this device. The eligibility discard depends on the global low water mark described in the **memory** command.

If a packet is received and the input queue current value is less than the input queue low threshold value, then the packet will be subject to flow control. For locally originated packets, a packet is subject to flow control if the number of free global buffers is less than the low threshold for global buffers. If a packet subject to flow control is to be transmitted on a device which has an output queue current value that is greater than the output queue high threshold (fair), then the packet is dropped instead of queued. When a packet is dropped due to flow control, the output discards counter is incremented and ELS event GW.036 or GW.057 is logged. If the packet was not locally originated, the input flow drop counter for the input interface is incremented. The output discards and input flow drop counters are displayed by the GWCON **error** command.

Due to the scheduling algorithms of the device, the dynamic numbers of Curr (particularly the Input Queue Curr) may not be fully representative of typical values during packet forwarding. The console code runs only when the input queues have been drained. Thus, Input Queue Curr will generally be nonzero only when those packets are waiting on slow transmit queues.

## Reset

Use the **reset** command to disable the specified interface and then re-enable it using new interface, protocol and feature configuration parameters. See "Resetting Interfaces" on page 69 for more information.

**Syntax:**

**reset** *interface#*

## Statistics

Use the **statistics** command to display statistical information about the network software, such as the configuration of the networks in the device.

**Syntax:**

**statistics** *interface#or range\_of\_interface#*

To display information about multiple interfaces, specify the *range\_of\_network#* (or a combination of *interface#* and *range\_of\_interface#*). For example, specifying **statistics 0 3 25-50** displays the information for nets 0, 3, and 25 through 50.



To display information about one interface only, enter the interface or network number as part of the command. To obtain the interface number, use the GWCON **configuration** command.

**Example:**

```
statistics
      Unicast  Multicast  Bytes  Packets  Bytes
Nt Interface Pkts Rcv  Pkts Rcv Received  Trans  Trans
0 Eth/0      137      1      8832   1068   65297
1 PPP/0       0        0        0        0        0
2 PPP/1       0        0        0        0        0
```

**Nt** Network interface number associated with the software.

**Interface**

Type of interface.

**Unicast Pkts Rcv**

Number of non-multicast, non-broadcast specifically-addressed packets at the MAC layer.

**Multicast Pkts Rcv**

Number of multicast or broadcast packets received.

**Bytes Received**

Number of bytes received at this interface at the MAC layer.

**Packets Trans**

Number of packets of unicast, multicast, or broadcast type transmitted.

**Bytes Trans**

Number of bytes transmitted at the MAC layer.

## Test

Use the **test** command to verify the state of an interface or to enable an interface that was previously disabled with the **disable** command. If the interface is enabled and passing traffic, the **test** command will remove the interface from the network and run self-diagnostic tests on the interface.

**Syntax:**

```
test                interface#
```

**Note:** For this command to work, you must enter the **complete** name of the command followed by the interface number.

Enter the interface or network number as part of the command. To obtain the interface number, use the GWCON **configuration** command. For example, when testing starts, the console displays the following message:

```
Testing net 0 Eth/0...
```

When testing completes or fails, or when GWCON times out (after 30 seconds), the following possible messages are displayed:

```
Testing net 0 Eth/0 ...successful
Testing net 0 Eth/0 ...failed
Testing net 0 Eth/0 ...still testing
```

Some interfaces may take more than 30 seconds before testing is done.

## GWCON Commands

**Note:** If the interface you are testing is configured as an alternate WAN Reroute interface, you are prompted:

- If you want to enable the interface's primary-alternate pairings if WAN Reroute is currently disabled for the alternate interface.

If you answer *yes*, the same action occurs as when you enter the **t 5 enable alternate-circuit** WAN reroute command described in Configuring and Monitoring WAN Restoral in *Using and Configuring Features*.

- If you want to test the interface.

Normally an alternate WAN Reroute interface is disabled until it is needed to back up its corresponding primary interface. If you answer *yes*, a self-test is started for the interface. If you answer *no*, a self-test does not occur.

See The WAN Reroute Feature, Using WAN Restoral, and Configuring and Monitoring WAN Restoral in the *Using and Configuring Features* for additional information.

## Uptime

Use the **uptime** command to display time statistics about the device, including the following:

- Number of restarts.
- Number of known crashes.
- Whether the device was last reloaded or restarted.
- Time elapsed since the last reload.
- Time elapsed since the last restart.

**Syntax:**

**uptime**

---

## Chapter 9. The Messaging (MONITR - Talk 2) Process

This chapter explains how to collect and display messages. (See “Chapter 10. Using the Event Logging System (ELS)” on page 127 for information about ELS and message formats. Refer also to the *IBM Nways Event Logging System Messages Guide* for a description of each message. This chapter includes the following sections:

- “What is Messaging (MONITR)?”
- “Commands Affecting Messaging”
- “Entering and Exiting the Messaging (MONITR) Process”
- “Receiving Messages”

---

### What is Messaging (MONITR)?

The MONITR process provides a view of activity inside the device and the networks. MONITR also displays logging messages from the software.

---

### Commands Affecting Messaging

The following commands affect the messaging process:

- OPCON commands:
  - **divert** temporarily diverts output to a different device.
  - **flush** causes the software to discard the messages it collects.
  - **halt** reverses the action of the divert command.
  - **talk** displays message output.
- CONFIG **set logging disposition** command sets the initial device to which the software sends its output.

---

### Entering and Exiting the Messaging (MONITR) Process

To enter the messaging process from OPCON enter the **event** command or the **talk 2** command.

The console displays the messages the software has accumulated.

To exit messaging and return to OPCON, enter the OPCON intercept character (the default is **Ctrl-P**).

---

### Receiving Messages

To receive messages at your console, enter the messaging process as described in the previous section. The software then displays all the messages it has recorded since it was last invoked. While you are connected to the messaging process, it displays all messages as they arrive.

Use the OPCON **divert** and **halt** commands to view software messages while you are doing something else with the device. Permitted devices divert output to TTY0 (the local console), TTY1, or TTY2 (the remote consoles).



---

## Chapter 10. Using the Event Logging System (ELS)

This chapter describes the Event Logging System (ELS). The ELS continually logs all events, filtering them according to parameters that you select. A combination of operational counters and the ELS provides information for monitoring the health and activity of the system. The information is divided into the following sections:

- “What is ELS?”
- “Entering and Exiting the ELS Configuration Environment”
- “Event Logging Concepts” on page 128
- “Using ELS” on page 131
- “Using ELS to Troubleshoot a Problem” on page 133
- “Using and Configuring ELS Remote Logging” on page 134
- “Using ELS Message Buffering” on page 142

---

### What is ELS?

ELS is a monitoring system and an integral part of the device operating system. ELS manages the messages logged as a result of device activity. Use ELS commands to set up a configuration that sorts out only those messages you feel are important. You can then display the messages on the console terminal screen, log them to a remote workstation, or send the messages to a network management station using Simple Network Management Protocol (SNMP) traps.

The ELS system and the operational counters are the best troubleshooting tools you have to isolate problems in the device. A quick scan of the event messages will tell you whether the device has a problem and where to start looking for it.

In the ELS configuration environment, the commands are used to establish a default configuration. This default configuration does not take effect until the device reinitializes.

Occasionally, it is helpful to temporarily view messages using parameters other than was set up in the ELS configuration environment, without having to reinitialize the device. The ELS operating and monitoring environment is used to:

- Temporarily change the default ELS display settings
  - Changes made in the ELS console environment take effect immediately.
  - Changes made in the operating/monitoring environment are not stored in nonvolatile configuration storage.
- View statistical information regarding ELS uses of dynamic RAM

**Note:** Specific ELS messages are described in the *IBM Nways Event Logging System Messages Guide*.

ELS is a subprocess that you access from the OPCODE process.

---

### Entering and Exiting the ELS Configuration Environment

The ELS configuration environment (available from the CONFIG process) is characterized by the ELS Config> prompt. Commands entered at this prompt create the ELS default state that takes effect after you restart the device. These commands are described in greater detail later in this chapter.

## Using ELS

Configuration commands that have subsystem, group, or event as a parameter are executed in the following order:

- Subsystem
- Group
- Event

To set a basic ELS configuration, enter the **display subsystem all standard** command at the ELS Config> prompt. This command configures the ELS to display messages from all subsystems with the STANDARD logging level (that is, all errors and unusual informational comments).

**Note:** The device does not have a default ELS configuration. You must enter the ELS configuration environment and set the default state.

To enter the ELS configuration environment from OPCON:

1. Enter the **configuration** command. The console displays the CONFIG prompt (Config>). If the prompt does not appear when you first enter CONFIG, press **enter**.
2. At the CONFIG prompt, enter the following command to access ELS:

```
Config> eve
```

The console displays the ELS configuration prompt (ELS config>). Now, you can enter ELS configuration commands.

To leave the ELS configuration environment, enter the **exit** command.

---

## Event Logging Concepts

This section describes how events are logged and how to interpret messages. Also described are the concepts of subsystem, event number, and logging level. A large part of ELS function is based on commands that accept the subsystem, event number, and logging level as parameters.

## Causes of Events

Events occur continuously while the device is operating. They can be caused by any of the following reasons:

- System activity
- Status changes
- Service requests
- Data transmission and reception
- Data and internal errors

When an event occurs, ELS receives data from the system that identifies the source and nature of the event. Then ELS generates a message that uses the data received as part of the message.

## Interpreting a Message

This section describes how to interpret a message generated by ELS. Figure 4 on page 129 shows the message contents.

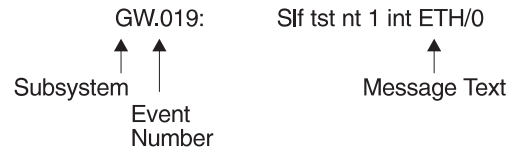


Figure 4. Message Generated by an Event

The information illustrated in Figure 4 as well as the ELS logging level information displayed with the **list subsystem** command is as follows:

### Subsystem

*Subsystem* is a predefined short name for a device component, such as a protocol or interface. In Figure 4, **GW** identifies the subsystem through which this event occurred.

Other examples of subsystems include IP and ETH. On a particular device, the actual subsystems present depend on the hardware and software configured for that device. You can use the **list subsystem** command described in this chapter to see a list of the subsystems on your device.

Enter the subsystem as a parameter to an ELS command when you want the command to affect the entire subsystem. For example, the ELS command **display subsystem GW** causes all events (except the events with 'debug' logging level) that occur through the GW subsystem to be displayed.

### Event Number

*Event Number* is a predefined, unique, arbitrary number assigned to each message within a subsystem. In Figure 4, **019** is the event number within the GW subsystem. You can see a list of all the events within a subsystem by using the **list subsystem** command, where *subsystem* is the short name for the subsystem.

The event number always appears with a subsystem identifier, separated by a period. For example: **GW.019**. The subsystem and event number together identify an *individual* event. They are entered as a parameter to certain ELS commands. When you want a command to affect only the specified event, enter the subsystem and event number as a parameter for the ELS command.

### Logging Level

*Logging level* is a predefined setting that classifies each message by the type of event that generated it. Use the **list subsystem** ELS console command to display the setting of the logging level. Table 13 lists the logging levels and types. ERROR, INFO, TRACE, STANDARD, and ALL are aggregates of other logging level types. STANDARD is the recommended default.

Table 13. Logging Levels

Logging Level	Type
UI ERROR	Unusual internal errors
CI ERROR	Common internal errors
UE ERROR	Unusual external errors
CE ERROR	Common external errors
ERROR	Includes all error levels above
UINFO	Unusual informational comment
CINFO	Common informational comment
INFO	Includes all comment levels above

## Using ELS

Table 13. Logging Levels (continued)

Logging Level	Type
STANDARD	Includes all error levels and all informational comment levels (default)
PTRACE	Per packet trace
UTRACE	Unusual operation Trace message
CTRACE	Common operation Trace message
TRACE	Includes all trace levels above
DEBUG	Message for debugging
ALL	Includes all logging levels

The logging level setting affects the operation of the following commands:

- **Display subsystem**
- **Nodisplay subsystem**
- **Trap subsystem**
- **Notrap subsystem**
- **Remote subsystem**
- **Noremote subsystem**

The logging level is set for a particular command when you specify it as a parameter to one of the above commands. For example:

```
display subsystem IP ERROR
```

Including the logging level on the command line modifies the **display** command so that whenever an event with a logging level of either UI-ERROR or CI-ERROR occurs through subsystem TKR, the console displays the resulting message.

You cannot specify the logging level for operations affecting groups or events.

### Message Text

*Message Text* appears in short form. In Figure 4 on page 129, S1f tst nt 1 int ETH/0 is the message generated by this event. Variables, such as *source\_address* or *network*, are replaced with actual data when the message displays on the console.

The variable *error\_code* is referred to by some of the Event Logging System message descriptions (usually preceded by *rsn* or *reason*). They indicate the type of packet error detected. Table 14 describes the error or packet completion codes. Packet completion codes indicate the disposition of the packets received by the device.

Table 14. Packet Completion Codes (Error Codes)

Code	Meaning
0	Packet successfully queued for output
1	Random, unidentified error
2	Packet not queued for output due to flow control reasons
3	Packet not queued because network is down
4	Packet not queued to avoid looping or bad broadcast
5	Packet not queued because destination host is down (only on networks where this can be detected)

ELS displays network information as follows:

```
nt 1 int Eth/0 (or ) network 1, interface Eth/0,
```

where:



- 1 is the network number (each network on the device is numbered sequentially from zero).
- 0 is the unit number (the interfaces of each hardware type are numbered sequentially from zero).

Ethernet and 802.5 hardware addresses appear as a long hexadecimal number.

IP (Internet Protocol) addresses are printed as 4 decimal bytes separated by periods, such as 18.123.0.16.

### Groups

*Groups* are user-defined collections of events that are given a name, the group name. Like the subsystem, subsystem and event number, and logging level, use the group name as a parameter to ELS commands. However, there are no predefined group names. You must create a group before you can specify its name on the command line.

To create a group, use the **add** configuration command, specify the name you want to call the group, and then specify the events you want to be part of the group. The events you add to the group can be from different subsystems and have different logging levels.

After creating a group, use the group name to manipulate the events in the group as a whole. For example, to turn off display of all messages from events that have been added to a group named *grouptwo*, include the group name on the command line, as follows:

```
nodisplay group grouptwo
```

To delete a group, use the **delete** command.

---

## Using ELS

To use ELS effectively, do the following:

- Know what you want before using the ELS system. Clearly define the problem or events that you want to see before using the MONITR process.
- Execute the command **nodisplay subsystem all all** to turn off all ELS messages.
- Turn on only those messages that relate to the problem you are experiencing.
- Use the *IBM Nways Event Logging System Messages Guide* to determine which messages are not normal.

When initially viewing ELS from the MONITR process, you will see a considerable amount of information. Because the device cannot buffer and display every packet under moderate to heavy loads the buffers are flushed. When this occurs the following message is displayed:

```
xx messages flushed
```

The device does not save these messages. When this message appears, tailor the ELS output to display only that information that is important to the current task you are monitoring, or use the advanced ELS commands to establish a message buffer. See "Using ELS Message Buffering" on page 142.

## Using ELS

### Managing ELS Message Rotation

It is also important to note that the ELS messages continually rotate through the device's buffers. To stop and restart the displaying of ELS messages, use the following key combinations:

**Ctrl-S** to pause scrolling

**Ctrl-Q** to resume scrolling

**Ctrl-P** to go back to the last process

You may also want to capture the ELS output to a file. You can do this by starting a script file or log file from your location when Telneting to a device. You can also do this by attaching a PC to the device's console port and starting a log file from within the terminal emulation package. This information is needed to help Customer Service diagnose a problem.

### Capturing ELS Output Using a Telnet Connection on a UNIX Host

Use a Telnet connection on an AIX® or UNIX® host to capture the ELS messages on your screen to a file on the host. Before beginning, set up ELS for the messages you want to capture using the ELS console commands in “Chapter 11. Configuring and Monitoring the Event Logging System (ELS)” on page 145.

To capture the ELS output to a file on an AIX or UNIX host, follow these steps:

1. From the host, enter **telnet device\_ip\_addr | tee local\_file\_name**
  - *device\_ip\_addr* is the IP address of the device
  - *local\_file\_name* is the name of the file on the host where you want the ELS messages to be saved.
  - The **tee** command displays the ELS messages on your screen and, at the same time, copies them to the local file.
2. From the OPCODE prompt (\*), enter **t 2**. This accesses the MONITR process, which is the process that displays ELS messages on your screen. Depending on which ELS messages you configured, you should see ELS messages appearing on the screen.

As long as you are in the MONITR process, all ELS messages will be written to the local file. When you exit the MONITR process (by entering **Ctrl-P**) or terminate the Telnet session, the logging of messages to the local file will stop.

You can also use remote logging instead of capturing ELS output on a UNIX Host. For more information about remote logging, see “Using and Configuring ELS Remote Logging” on page 134.

### Configuring ELS So Event Messages Are Sent In SNMP Traps

ELS can be configured so that event messages are sent to a network management workstation in an SNMP enterprise-specific trap. These traps are useful for reporting status and diagnostic results, and are often used for remote monitoring of the 2216. When ELS is configured appropriately, an SNMP trap will be generated each time the selected event occurs. For more information about SNMP, see *Protocol Configuration and Monitoring Reference*.

To tell ELS that a specific event should be activated to be sent as an SNMP trap, at the ELS config> prompt or at the ELS> prompt, type:

```
trap event ip.007
```

**Note:** If you are at the ELS config> prompt, you will need to reboot.

To enable the ELS enterprise-specific trap, follow these steps:

1. At the SNMP config> prompt, using **public** as an example, type:

```
SNMP config> add address public <network manager IP address>
SNMP config> enable trap enterprise public
SNMP config> set community access read_trap public
```

**Note:** You need to reboot to activate these changes.

2. Enable your network management station to receive and properly display the enterprise-specific traps.

Follow these steps to trap groups, subsystems, and events.

---

## Using ELS to Troubleshoot a Problem

If you are trying to troubleshoot a particular problem, display the messages related to the problem. For example, if experiencing a problem with bridging, turn on the bridging messages:

```
display subsystem srt all
display subsystem br all
```

Initially, because of the rapid pace of messages scrolling across the screen, you may want to record the numbers you see and look them up in the *Event Logging System Messages Guide* manual. Once you become familiar with different types of messages being displayed for a particular protocol, you can turn on and turn off only those messages that contain the information that you require to troubleshoot a problem. The following sections list specific ELS examples. Keep in mind that different problems may require different steps.

### ELS Example 1

You are interested in looking at the frequency of polling on a Token-Ring interface, and finding out whether the polls are successful.

```
ELS> nodisplay subsystem all all
ELS> display subsystem tkr all
Ctrl-P
* t 2
```

As the messages begin to scroll by, look for ELS message tkr.031.

### ELS Example 2

SRB bridging is not working.

1. Check the configuration.
2. Use the GWCON bridging console to verify that the bridging interfaces are enabled.
3. Enter:

```
* t 6
config> event
ELS config> nodisplay subsystem all all
ELS config> display subsystem srb all
ELS config> exit
config> Ctrl-P
```

4. Restart the routing subsystem. When the subsystem has restarted, enter the following:

```
* t 2
```

## Using ELS

### ELS Example 3

Router cannot communicate with an IPX server on an Ethernet.

1. Enter the **talk** command and the PID for GWCON.

```
* t 5
```

The console displays the GWCON prompt (+). If the prompt does not appear when you first enter GWCON, press **Return**.

2. At the GWCON prompt (+), enter **IPX** to access the IPX console prompt (IPX>).
3. At the IPX console prompt, enter the **slist** command to verify that the server is listed. (See the section on monitoring IPX in the *Protocol Configuration and Monitoring Reference* for information on the **slist** command.)
4. Check the IPX configuration.
5. Enter the following:

```
* t 5
+ event
ELS> nodisplay subsystem all all
ELS> display subsystem IPX all
ELS> display subsystem eth all
ELS> Ctrl-P
* t 2
```

As the messages begin to scroll by, look for ELS message eth.001. This indicates that the server has a bad Ethernet type field.

---

## Using and Configuring ELS Remote Logging

The remotely-logged ELS message contains all of the information that is contained in ELS messages found in the monitor queue, as viewed under **talk 2**, and also contains additional information as shown in Figure 5.

Date/Time	IP address assigned by the user	Sequence Number used for detecting missing messages	Local Name assigned by the user	ELS Subsystem Name, & Formatted message
Nov 20 12:13:47	5.1.1.1	Msg [0444] from	** IBM/2216 **	:els: MPC.011 Del ent ...

Figure 5. Syslog Message Description

Note the following differences in the remote log display:

- The month and day of month in addition to the time, which is always displayed as the time-of-day.
- An IP address, which is the user-specified source IP address. If a DNS server resolves the source IP address to a hostname, then the hostname will be displayed instead of the IP address.
- A Sequence number is added to the message by the source device to assist in detecting dropped messages. See “Remote Logging Output” on page 138 for an explanation of dropped messages. When the sequence number of the message reaches 9999, the next sequence number is 0001.
- A “Local Name” for the source device, to assist in distinguishing between messages from multiple sources. If you do not configure a local name, this field is blank.

## Syslog Facility and Level

Remotely-logged ELS messages are transmitted over the network in UDP packets with the destination port number in the UDP header always equal to 514, the syslog port. To receive and process the UDP packets, the *syslog daemon* (*syslogd*) must be running in the remote workstation that is receiving and logging the ELS messages. See “Remote Workstation Configuration” for details.

Although it is not displayed in the remotely-logged ELS message, every ELS message sent on the network in a UDP packet must be assigned a *syslog\_facility* and a *syslog\_level*. The syslog daemon uses the combination of facility and level to determine where to route the message. Typically, you want the ELS messages to be written to one or more files in the remote host. Other options include displaying the message on the console, sending the message to one or more users, or sending the message to another workstation.

The commands you use to specify the *syslog\_facility* and *syslog\_level* values, along with other remote-logging related console commands, are described in “ELS Monitoring Commands” on page 166 and “ELS Configuration Commands” on page 145. Review these commands before reading through the next section.

## Remote Workstation Configuration

The following configuration assumes that a single 2216 is remote-logging to a single remote workstation. You can configure multiple 2216s to remote-log to the same remote workstation. However, a particular 2216 can log to one and only one remote workstation. The operating system used in this example is AIX 4.2. Your environment may be slightly different. For more information on syslog, refer to the documentation for your operating system.

To perform the configuration on an AIX workstation, you must log in as **root**. To configure the workstation:

1. Create or edit a *syslog.conf* file to specify where ELS messages with particular *syslog\_facility* and *syslog\_level* values are to be written. See the bottom of Figure 6 on page 136 for an example of how to specify the message destination. Note that the full pathname of the log files must be specified. The default location for the syslog configuration file is */etc/syslog.conf*.
2. Create the files for logging syslog messages that you specified in the *syslog.conf* file.
3. Start the syslog daemon by entering **syslogd**. To start the syslog daemon from SRC (System Resource Controller), enter **startsrc -s syslogd**. If the pathname of the configuration file is not */etc/syslog.conf*, then enter **syslogd -f pathname**. To start the syslog daemon in debug mode, enter **syslogd -d**.

**Note:** Running multiple instances of the syslog daemon is not supported.

4. If the syslog daemon is already running when you create or modify the *syslog.conf* file, it must be restarted so that the daemon reinitializes the configuration from *syslog.conf*.
5. Verify the setup by using the **logger** command as follows:

```
logger -p user.alert THIS IS A TEST MESSAGE (user.alert)
logger -p news.info THIS IS A TEST MESSAGE (news.info)
```

If the setup is correct, THIS IS A TEST MESSAGE... will be written to the files specified in *syslog.conf*.

## Using ELS

```
# @(#)34      1.9 src/bos/etc/syslog/syslog.conf, cmdnet, bos411, 9428A410j 6/13/93 14:52:39
#
# COMPONENT_NAME: (CMDNET) Network commands.
#
# FUNCTIONS:
#
# ORIGINS: 27
#
# (C) COPYRIGHT International Business Machines Corp. 1988, 1989
# All Rights Reserved
# Licensed Materials - Property of IBM
#
# US Government Users Restricted Rights - Use, duplication or
# disclosure restricted by GSA ADP Schedule Contract with IBM Corp.
#
# /etc/syslog.conf - control output of syslogd
#
# Each line must consist of two parts:-
#
# 1) A selector to determine the message priorities to which the
#    line applies
# 2) An action.
#
# The two fields must be separated by one or more tabs or spaces.
#
# format:
#
# <msg_src_list>          <destination>
#
# where <msg_src_list> is a semicolon separated list of <facility>.<priority>
# where:
#
# <facility> is:
# * - all (except mark)
# kern,user,mail,daemon, auth, syslog, lpr, news, uucp, cron, authpriv, local0 - local7
#
# <priority or level> is one of (from high to low):
# emerg,alert,crit,err(or),warn(ing),notice,info,debug
# (meaning all messages of this priority or higher)
#
# <destination> is:
# /filename - log to this file
# username[,username2...] - write to user(s)
# @hostname - send to syslogd on this machine
# * - send to all logged in users
#
# example:
# "mail messages, at debug or higher, go to Log file. File must exist."
# "all facilities, at debug and higher, go to console"
# "all facilities, at crit or higher, go to all users"
# mail.debug          /usr/spool/mqueue/syslog
# *.debug             /dev/console
# *.crit              *
#
#   syslog messages with facility / priority values of LOG_USER,  LOG_ALERT
user.alert           /tmp/syslog_user_alert
#
#   syslog messages with facility / priority values of LOG_NEWS,  LOG_INFO
news.info            /tmp/syslog_news_info
```

Figure 6. *syslog.conf* Configuration File

## Configuring the 2216 for Remote Logging

To configure a 2216:

1. In talk 6, configure the remote-logging facility as shown in Figure 7 on page 137. The IP address specified as the *source-ip-addr* should be an IP address that is configured in the 2216 for easier identification when the IP address or the hostname is shown in the remotely-logged ELS message. You should also verify that this IP address resolves quickly into a hostname by the name server or that the name server at least responds quickly with "address not found." To determine whether this happens, issue the **host** command on your workstation as follows:

```
workstation> host 5.1.1.1
host: address 5.1.1.1 NOT FOUND
workstation>
```

If the response takes more than 1 second, select an IP address which resolves more quickly.

2. In talk 6 configure events and subsystems for remote-logging, as shown in Figure 8 on page 138.
3. Write the configuration and reload the device.

```
ELS config>set remote source-ip-addr 5.1.1.1
Source IP Addr = 5.1.1.1

ELS config>set remote remote-ip-addr 192.9.200.1
Remote Log IP Addr = 192.9.200.1

ELS config>set remote local-id ** IBM/2216 **
Remote Log Local ID = ** IBM/2216 **

ELS config>set remote no-msgs-in-buffer 100
Number of messages in Remote Log Buffer must be 100-512
Number of Messages in Remote Buffer = 100

ELS config><B>set remote facility log_news
Default Syslog Facility = LOG_NEWS

ELS config>set remote level log_info
Default Syslog Level = LOG_INFO

ELS config>set remote on
Remote Logging is ON

ELS config>list remote

----- Remote Log Status -----

Remote Logging is ON
Source IP Address = 5.1.1.1
Remote Log IP Address = 192.9.200.1
Default Syslog Facility = LOG_NEWS
Default Syslog Priority Level = LOG_INFO
Number of Messages in Remote Log = 100
Remote Logging Local ID = ** IBM / 2216 **
ELS config>
```

*Figure 7. Configuring the 2216 for Remote Logging*

## Using ELS

```
ELS config>display sub snmp all
ELS config>remote sub snmp all log_news log_info

ELS config>display event srt.017
ELS config>remote event srt.017 log_news log_info

ELS config>display event stp.016
ELS config>remote event stp.016 log_user log_info

ELS config>display event stp.026
ELS config>remote event stp.026 log_news log_info

ELS config>display event stp.024
ELS config>remote event stp.024 log_news log_info

ELS config>display event ip.068
ELS config>remote event ip.068 log_news log_info

ELS config>display event ip.058
ELS config>remote event ip.058 log_news log_info

ELS config>display event ip.022
ELS config>remote event ip.022 log_news log_info

ELS config>display event gw.022
ELS config>remote event gw.22 log_news log_info

ELS config>display event arp.011
ELS config>remote event arp.011 log_user log_alert

ELS config>display event arp.002
ELS config>remote event arp.022 log_user log_alert

ELS config>list status
Subsystem:      SNMP
Disp levels:   ERROR INFO TRACE
Trap levels:   none
Trace levels:  none
Remote levels: ERROR INFO TRACE
               Syslog Facility/Level: LOG_NEWS LOG_INFO

Event   Display Trap   Trace   Remote
SRT.017 On      Unset   Unset   On
        Syslog Facility/Level: LOG_NEWS LOG_INFO
STP.016 On      Unset   Unset   On
        Syslog Facility/Level: LOG_NEWS LOG_INFO
STP.026 On      Unset   Unset   On
        Syslog Facility/Level: LOG_NEWS LOG_INFO
STP.024 On      Unset   Unset   On
        Syslog Facility/Level: LOG_NEWS LOG_INFO
IP.068  On      Unset   Unset   On
        Syslog Facility/Level: LOG_NEWS LOG_INFO
IP.058  On      Unset   Unset   On
        Syslog Facility/Level: LOG_NEWS LOG_INFO
IP.022  On      Unset   Unset   On
        Syslog Facility/Level: LOG_NEWS LOG_INFO
GW.022  On      Unset   Unset   On
        Syslog Facility/Level: LOG_NEWS LOG_INFO
ARP.011 On      Unset   Unset   On
        Syslog Facility/Level: LOG_USER LOG_ALERT
ARP.002 On      Unset   Unset   On
        Syslog Facility/Level: LOG_USER LOG_ALERT
```

Figure 8. Configuring Subsystems and Events for Remote Logging

## Remote Logging Output

Figure 9 on page 139 shows a sample from the /tmp/syslog\_news\_info file. Notice that the first message has a sequence number of 310. This means that the first 309 ELS messages were not sent from the source 2216. There are several reasons for this:

- The remote-logging facility had not completed initialization when the messages were first passed to ELS



- A route from the source 2216 to the remote workstation was not in the routing table
- The interface for the outbound UDP packet containing the ELS messages was not in the “Up” state

Notice in **1** that messages 311-313 did not get remote-logged. This is because an ARP request was outstanding and until the ARP response is received, all but the first packet is dropped in the source 2216. Additionally, the ARP cache is cleared at a user-configured refresh rate, and a new ARP request is issued. To determine when this is occurring, you can remote log events ARP.002 and ARP.011 in addition to the primary ELS events of interest. Figure 11 on page 140 shows ARP events logged to the *syslog\_user\_alert* file that account for events 445 and 446, which were indicated as missing in Figure 9.

```
Nov 20 12:03:16 worksta01 root: THIS IS A TEST MESSAGE (news.info)
Nov 20 12:08:48 5.1.1.1 Msg [0310] from ** IBM / 2216 **: els: IP.022: add nt 192.9.200.0 int 192.9.200.20
nt 0 int Eth/0

1 ( messages 311, 312, and 313 did not get remote-logged due to ARP request outstanding - see
explanation in the text)

2 (messages 314 and 315 were logged to a separate
file - see explanation in the text)

Nov 20 12:08:48 5.1.1.1 Msg [0316] from ** IBM / 2216 **: els: IP.068: routing cache cleared
Nov 20 12:08:48 5.1.1.1 Msg [0317] from ** IBM / 2216 **: els: IP.022: add nt 5.0.0.0 int 5.1.1.1 nt 5 int Eth/4
Nov 20 12:08:48 5.1.1.1 Msg [0318] from ** IBM / 2216 **: els: SRT.017: Enabling SRT on port 5 nt 5 int Eth/4

(message 319 was logged to a separate file)

Nov 20 12:08:48 5.1.1.1 Msg [0320] from ** IBM / 2216 **: els: IP.068: routing cache cleared

(120 messages not shown)

Nov 20 12:13:33 5.1.1.1 Msg [0441] from ** IBM / 2216 **: els: GW.022: Nt fld slf tst nt 3 int Eth/3
Nov 20 12:13:33 5.1.1.1 Msg [0442] from ** IBM / 2216 **: els: GW.022: Nt fld slf tst nt 6 int Eth/5
Nov 20 12:13:38 5.1.1.1 Msg [0443] from ** IBM / 2216 **: els: GW.022: Nt fld slf tst nt 11 int ISDN/0

(messages 444 and 447 were logged to a separate file)

(messages 445 and 446 did not get remote-logged due to ARP request outstanding)

Nov 20 12:13:50 5.1.1.1 Msg [0448] from ** IBM / 2216 **: els: GW.022: Nt fld slf tst nt 4 int PPP/0
Nov 20 12:13:50 5.1.1.1 Msg [0449] from ** IBM / 2216 **: els: IP.068: routing cache cleared
Nov 20 12:13:50 5.1.1.1 Msg [0450] from ** IBM / 2216 **: els: IP.058: del nt 4.0.0.0 rt via 0.0.0.4 nt 4 int PPP/0
```

Figure 9. Sample Contents from Syslog News Info File

If the initial ELS messages that are generated during and immediately after booting are of particular interest, then it is recommended that these messages also be displayed in the monitor queue, which is viewed with talk 2. Figure 10 on page 140 shows the talk 2 output including the initial messages that did not get remote-logged. Note that there is a message in the talk 2 output that indicates that the remote-logging facility is available. This does not indicate that a route exists to the remote workstation, nor that the associated interface is in the “Up” state. It simply provides a reference point before which no messages can be successfully remote-logged.

Also notice that you can account for the messages that were missing (indicated in Figure 9 with **2**) in the talk 2 output.

## Using ELS

```
12:08:17 SNMP.024: generic trc (P2) at snmp_mg.c(766): Now 0 trap destinations
12:08:17 SNMP.012: comm public added
12:08:17 SNMP.012: comm public added
12:08:27 SNMP.022: ext err (Z1) at snmp_resconf.c(322): add_device_if_info(): sr
rdrec failed

12:08:27 SNMP.022: ext err (Z1) at snmp_resconf.c(322): add_device_if_info(): sr
rdrec failed

12:08:27 SNMP.028: err (E2) at snmp_moh.c(1583) : Duplicate
12:08:27 SNMP.028: err (E2) at snmp_moh.c(1583) : Duplicate
12:08:28 GW.022: Nt fld slf tst nt 13 int PPP/3
12:08:28 IP.022: add nt 4.0.0.0 int 4.1.1.1 nt 4 int PPP/0

    ( 297 messages not shown )

12:08:43 GW.022: Nt fld slf tst nt 12 int PPP/2
12:08:43 GW.022: Nt fld slf tst nt 13 int PPP/3
12:08:48 IP.022: add nt 192.9.200.0 int 192.9.200.20 nt 0 int Eth/0
12:08:48 SRT.017: Enabling SRT on port 1 nt 0 int Eth/0
12:08:48 STP.016: Select as root TB-1, det topol chg
12:08:48 STP.026: Root TB-1, strt hello tmr
12:08:48 ARP.002: Pkt in 1 1 800 nt 0 int Eth/0
12:08:48 ARP.002: Pkt in 2 1 800 nt 0 int Eth/0
12:08:48 IP.068: routing cache cleared

    ( 126 messages not shown )

12:13:38 GW.022: Nt fld slf tst nt 11 int ISDN/0
12:13:47 ARP.011: Del ent 1 3 nt 0 int Eth/0
12:13:47 ARP.011: Del ent 1 3 nt 0 int Eth/0
12:13:47 ARP.002: Pkt in 1 1 800 nt 5 int Eth/4
12:13:47 ARP.002: Pkt in 2 1 800 nt 0 int Eth/0
12:13:50 GW.022: Nt fld slf tst nt 4 int PPP/0
```

*Corresponding Sequence  
Numbers in  
Remote-Logging Files :*

```
[0310] first message logged
-- not logged (ARP request) --
-- not logged (ARP request)--
-- not logged (ARP request)--
[0314]
[0315]
[0316]

[0443]
[0444]
-- not logged (ARP request) --
-- not logged (ARP request)--
[0447]
[0448]
```

Figure 10. Output from Talk 2

You can use the timestamp, which appears in both the remote-logging output file and the talk 2 output, to determine when the first ELS message is successfully remote-logged. To use the timestamp for this purpose, configure ELS such that the timestamp in the monitor queue displays the time-of-day.

Also notice in Figure 9 on page 139 that messages 311-313 did not get remote-logged. This is because an ARP request was outstanding and until the ARP response is received, all but the first packet is dropped in the source IBM 2216. The ARP cache is cleared at a user-configured refresh rate, and the device issues a new ARP request. To determine when ARP requests are occurring, events ARP.002 and ARP.011 can be remote-logged, in addition to the ELS events of interest. Figure 11 shows ARP events logged to the *syslog\_user\_alert* file that account for events 445 and 446, which were indicated as missing in Figure 9 on page 139.

```
Nov 20 12:02:53 worksta01 root: THIS IS A TEST MESSAGE (user.alert)
Nov 20 12:08:48 5.1.1.1 Msg [0314] from ** IBM / 2216 **: els: ARP.002: Pkt in 1 1 800 nt 0 int Eth/0
Nov 20 12:08:48 5.1.1.1 Msg [0315] from ** IBM / 2216 **: els: ARP.002: Pkt in 2 1 800 nt 0 int Eth/0
Nov 20 12:08:48 5.1.1.1 Msg [0319] from ** IBM / 2216 **: els: ARP.002: Pkt in 2 1 800 nt 0 int Eth/0
Nov 20 12:13:47 5.1.1.1 Msg [0444] from ** IBM / 2216 **: els: ARP.011: Del ent 1 3 nt 0 int Eth/0
Nov 20 12:13:47 5.1.1.1 Msg [0447] from ** IBM / 2216 **: els: ARP.002: Pkt in 2 1 800 nt 0 int Eth/0
```

Figure 11. Sample Contents from Syslog\_user\_alert File

You can prevent the loss of ELS messages caused by this ARP sequence by establishing a static relationship between the IP address and the MAC address. The basic steps are outlined below and are illustrated in Figure 12 on page 141.

1. In talk 5, "ping" the remote workstation's IP address
2. In talk 5, determine the interface (net) number used to send messages to the remote-workstation's IP address
3. Use the net number from the previous step to determine the associated MAC address

4. In talk 6, add an ARP entry to establish a static IP address to MAC address relationship

```

*t 5
+p ip

IP>ping 192.9.200.1
PING 192.9.200.20 -> 192.9.200.1: 56 data bytes, ttl=64, every 1 sec.
56 data bytes from 192.9.200.1: icmp_seq=0. ttl=64. time=0. ms
----192.9.200.1 PING Statistics----
1 packets transmitted, 1 packets received, 0% packet loss
round-trip min/avg/max = 0/0/0 ms

IP>dump

  Type  Dest net          Mask          Cost   Age      Next hop(s)
  .
  Dir*  192.9.200.0      FFFFFFF0      1      102305   Eth/0
  .
IP>exit
+int

Net  Net'  Interface  Slot-Port          Self-Test  Self-Test  Maintenance
0    0     Eth/0     Slot: 1  Port: 1          Passed    Failed     Failed
                                1          0              0
  .
+p arp
ARP>dump
Network number to dump [0]? 0
Hardware Address      IP Address      Refresh
02-60-8C-2D-69-5D   192.9.200.1    2

Ctrl-P
*t 6
config>p arp
ARP config>add entry
Interface Number [0]? 0
Protocol [IP]? IP
IP Address [0.0.0.0]? 192.9.200.1
Mac Address []? 02608C2D695D
ARP config> list entry

Mac address translation configuration

IF #      Prot #  Protocol -> Mac address
0         0      192.9.200.1 -> 02608C2D695D
ARP config>exit
Config>write

Ctrl-P

*reload
Are you sure you want to reload the gateway? (Yes or [No]): Yes

(after reload, static ARP entry is active)

```

Figure 12. Example of Setting Up a Static ARP Entry

## Additional Considerations

### ELS Messages Containing IP Addresses

ELS messages containing an IP address which matches the IP address of the remote workstation will not be remote-logged, even if configured for remote-logging, and may appear under talk 2. These messages are discarded instead of being remote-logged in order to prevent excessive UDP packets from being sent on the network.

### Duplicate Logging

If a facility value is repeated in *syslog.conf*, for example:

```

user.debug      /tmp/syslog_user_debug
user.alert      /tmp/syslog_user_alert

```

## Using ELS

The syslog daemon will log *user.debug* messages only to the */tmp/syslog\_user\_debug* file while *user.alert* messages will be logged to both the */tmp/syslog\_user\_debug* file and the */tmp/syslog\_user\_alert* file. This is consistent with the syslog design that logs the more severe conditions in multiple places.

To prevent this duplicate logging, it is recommended that different facility values be specified in the *syslog.conf* file. A total of 19 facility values are available.

### Recurring Sequence Numbers in Syslog Output Files

Depending upon the configuration of your network, it is possible for duplicate UDP packets containing ELS messages to arrive at the remote host. It is also possible for the packets to arrive in a different order than they were transmitted. An example of this phenomenon is shown in Figure 13. Notice that the messages with sequence numbers 628 through 633 are logged twice. Also notice that after the first occurrence of sequence number 0630, sequence number 0629 occurs again, followed by the second occurrence of 0630.

```
Apr 01 10:48:33 0.0.0.0 Msg [0628] from: RA22: : els: IPX.018: SAP gen rply sent nt 5 int TKR/1, 1 pkts
Apr 01 10:48:33 0.0.0.0 Msg [0628] from: RA22: : els: IPX.018: SAP gen rply sent nt 5 int TKR/1, 1 pkts
Apr 01 10:49:08 0.0.0.0 Msg [0629] from: RA22: : els: IPX.037: RIP resp sent nt 0 int TKR/0, 1 pkts
Apr 01 10:49:08 0.0.0.0 Msg [0630] from: RA22: : els: IPX.018: SAP gen rply sent nt 0 int TKR/0, 1 pkts
Apr 01 10:49:08 0.0.0.0 Msg [0629] from: RA22: : els: IPX.037: RIP resp sent nt 0 int TKR/0, 1 pkts
Apr 01 10:49:08 0.0.0.0 Msg [0630] from: RA22: : els: IPX.018: SAP gen rply sent nt 0 int TKR/0, 1 pkts
Apr 01 10:49:33 0.0.0.0 Msg [0631] from: RA22: : els: IPX.037: RIP resp sent nt 5 int TKR/1, 1 pkts
Apr 01 10:49:33 0.0.0.0 Msg [0631] from: RA22: : els: IPX.037: RIP resp sent nt 5 int TKR/1, 1 pkts
Apr 01 10:49:33 0.0.0.0 Msg [0632] from: RA22: : els: IPX.018: SAP gen rply sent nt 5 int TKR/1, 1 pkts
Apr 01 10:49:33 0.0.0.0 Msg [0632] from: RA22: : els: IPX.018: SAP gen rply sent nt 5 int TKR/1, 1 pkts
Apr 01 10:50:08 0.0.0.0 Msg [0633] from: RA22: : els: IPX.037: RIP resp sent nt 0 int TKR/0, 1 pkts
Apr 01 10:50:08 0.0.0.0 Msg [0633] from: RA22: : els: IPX.037: RIP resp sent nt 0 int TKR/0, 1 pkts
```

Figure 13. Example of Recurring Sequence Numbers in Syslog Output

Because neither Syslog nor UDP has the ability to handle duplicate or out of sequence packets, it is important to recognize the possibility of duplicate sequence numbers occurring.

---

## Using ELS Message Buffering

Message buffering is an advanced feature of ELS that can help you with problem determination. You can set up defaults that ELS will use for message buffering or change how messages are buffered while the device is operating. Message buffering can minimize the information lost because messages have wrapped in the default message buffers. Message buffering is accessible through the **advanced** configuration or monitoring command. It enables you to:

- Specify whether buffering is active.
- Specify what events are written to the message buffer.
- Stop buffering and free the memory allocated for buffering.
- Display the status of the message buffer.
- Specify an event that stops message buffering and what action the system takes when the event occurs.
- Send a formatted version of the buffer to a file at a remote server.
- View a specific number or all of the ELS messages in the buffer.
- Write the buffer to a hard drive if a hard drive is present.
- Read a file that contains a formatted ELS message buffer from the hard drive , if a hard drive is present.

- Send a file that contains a formatted ELS message buffer from the hard drive , if a hard drive is present.

For specifics about the commands, see “ELS Message Buffering Configuration Commands” on page 162 and “ELS Message Buffering Monitoring Commands” on page 190.

The following example shows how to configure ELS message buffering.

**Note:** Setting of the Advanced ELS buffer size must be performed under talk 6. The remaining setup steps can be performed under either talk 5 or talk 6.

```
*t 6
Gateway user configuration
Config>event
Event Logging System user configuration
ELS config>advanced
Advanced ELS Config Console
ELS Config Advanced>set buffer
Enter buffer size in range 0 to 15219 KB [5073]?
Buffer size set to 5073 KB
NOTE: Any more config changes made before rebooting
could affect the availability of sufficient memory after
reboot!
ELS Config Advanced>exit
ELS config>exit
Config>write
Config>
*reload
Are you sure you want to reload the gateway? (Yes or [No]): Yes
```

(after reloading...)

```
*t 5
CGW Operator Console

+event
Event Logging System user console
ELS>advanced
Advanced ELS Console
ELS Advanced>list status
-----Advanced ELS Configuration-----
Logging Status: OFF Wrap Mode: ON Logging Buffer Size: 5073 KB
Stop-Event: NONE Stop-String: NONE
Additional Stop-Action: NONE
-----Run-Time Status-----
Has Stop Condition Occurred? NO Messages currently in buffer: 0

ELS Advanced>set stop event gw.26
Stop Event "GW.026" has been set
ELS Advanced>set stop string Mnt nt 5
Stop String set to "Mnt nt 5"
ELS Advanced>set stop action APPN-DUMP
Stop Action has been set to APPN-DUMP
ELS Advanced>set wrap off
Advanced Wrap Mode set to OFF.

ELS Advanced>log subsys gw all
ELS Advanced>set logging on
Advanced Logging set to ON.
ELS Advanced>list status
-----Advanced ELS Configuration-----
Logging Status: OFF Wrap Mode: OFF Logging Buffer Size: 5073 KB
Stop-Event: GW.026 Stop-String: Mnt nt 5
Additional Stop-Action: APPN-DUMP
-----Run-Time Status-----
Has Stop Condition Occurred? YES Messages currently in buffer: 2

ELS Advanced>view all noscroll

[1] 10:52:10 GW.026: Mnt nt 0 int Eth/0
[2] 10:52:10 GW.026: Mnt nt 5 int Eth/1 1
```

**1** This triggered the stop action.

---

## Chapter 11. Configuring and Monitoring the Event Logging System (ELS)

This chapter describes how to configure events logged by ELS and how to use the ELS commands. The information includes the following sections:

- “Accessing the ELS Configuration Environment”
- “ELS Configuration Commands”
- “Entering and Exiting the ELS Operating Environment” on page 166
- “ELS Monitoring Commands” on page 166

For more information on the Event Logging System and how to interpret ELS event messages, refer to “Chapter 10. Using the Event Logging System (ELS)” on page 127.

---

### Accessing the ELS Configuration Environment

The ELS configuration environment is characterized by the ELS `config>` prompt. Commands entered at this prompt are described “Chapter 11. Configuring and Monitoring the Event Logging System (ELS)”.

To enter the ELS configuration environment:

1. Enter **configuration**.

The monitoring displays the `Config>` prompt. If the prompt does not appear, press **enter**.

2. At the `Config>` prompt, enter the following command to access ELS:

```
event
```

The monitoring displays the ELS configuration prompt (`ELS config>`). Now, you can enter ELS configuration commands.

To leave the ELS configuration environment, enter the **exit** command.

---

### ELS Configuration Commands

Table 15 summarizes the ELS configuration commands. The remainder of this section describes each one in detail. After accessing the ELS configuration environment, you can enter ELS Configuration commands at the ELS `Config>` prompt.

*Table 15. ELS Configuration Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Adds an event to an existing group or creates a new group.
Advanced	Places you in the advanced configuration environment in which you can configure message buffering.
Clear	Clears all ELS configuration information.
Default	Resets the display or trap setting of an event, group, or subsystem.
Delete	Deletes an event number from an existing group or deletes an entire group.
Display	Enables message display on the console monitor.
Filter	Filter ELS messages based upon the net number.

## ELS Configuration Commands (Talk 6)

Table 15. ELS Configuration Command Summary (continued)

Command	Function
List	Lists information on ELS settings and messages.
Nodisplay	Disables message display on the console.
Noremote	Disables remote logging to a remote workstation.
Notrace	Controls disablement of packet trace events.
Notrap	Keeps messages from being sent out in SNMP traps.
Remote	Allows messages to be logged to a remote workstation.
Set	Sets the pin parameter and the timestamp feature options.
Trace	Controls enablement of packet trace events.
Trap	Allows messages to be sent to a network management workstation in SNMP traps.
View	Allows viewing of traced packets.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### Add

Use the **add** command to add an individual event to an existing group or to create a new group. Group names must start with a letter and are case sensitive. You cannot append an entire subsystem to a group.

**Syntax:**

**add** *group\_name subsystem.event\_number*

**Note:** If the specified group does not exist, the following prompt asks you to confirm the creation of a new group:

Group not found. Create new group? (yes or no)

### Advanced

Use the **advanced** command to enter the advanced configuration environment. In this environment you configure message buffering.

**Syntax:**

**advanced**

### Clear

Use the **clear** command to clear all of the ELS configuration information.

**Syntax:**

**clear**

**Example:**

```
clear
```

```
You are about to clear all ELS configuration information
Are you sure you want to do this (Yes or No):
```

### Default

Resets the display or trap setting of an event, group, or subsystem back to a disabled state.

**Syntax:**



## ELS Configuration Commands (Talk 6)

**default**                            display  
  trap  
  remote  
**display** *event or group or subsystem*  
Controls the output of the display of messages to the monitoring.  
**trap** *event or group or subsystem*  
Controls the generation of traps to the network management station.  
**remote** *event or group or subsystem*  
Controls the generation of traps to the remote station.

## Delete

Use the **delete** command to delete an event number from an existing group or to delete the entire group. If the specified event is the last event to be deleted in a group, you will be notified. If *all* is specified instead of *subsystem.event\_number*, a prompt asks you to confirm the deletion of the entire group.

### Syntax:

**delete**                                *group\_name subsystem.event\_number*

## Display

Use the **display** command to enable message displaying on the monitoring monitor for specific events, a range of events for a subsystem, groups, or subsystems.

### Syntax:

**display**                                event . . .  
  group . . .  
  range . . .  
  subsystem . . .

**event** *subsystem.event#*

Displays messages of the specified event (*subsystem.event#*).

**group** *groupname*

Displays messages of a specified group (*groupname*).

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event in the specified event range.

Displays a range of messages for the specified subsystem.

### Example:

```
display range gw 19 22
```

Displays events gw.19, gw.20, gw.21, and gw.22.

**subsystem** *subsystemname*

Displays messages associated with the specified subsystem. To find out which subsystems are on the device, type **list subsystems**.

**Note:** Although ELS supports all subsystems on the device, not all devices support all subsystems. See *Event Logging System Messages Guide* for a list of currently supported subsystems.

## ELS Configuration Commands (Talk 6)

### Filter

Use the **filter** command to access the filter configuration command environment. See “ELS Net Filter Configuration Commands” on page 160 for complete command details.

#### Syntax:

**filter** net

### List

Use the **list** command to get updated information regarding ELS settings and listings of selected messages.

#### Syntax:

**list** all  
filter-status  
groups  
pin  
remote-log status  
status  
subsystem . . .  
subsystems all  
trace-status

**all** Lists information from all the **list** categories.

#### **filter-status**

Lists ELS net number filters.

#### **groups**

Lists the user-defined group names and contents.

#### **pin**

Lists the current number of ELS event messages sent in SNMP traps (per second).

#### **remote-log status**

Lists the current values of remote logging options.

#### **Example:**

```
list r
```

```
Remote Logging is ON
Source IP Address = 192.67.38.2
Remote Log IP Address = 192.9.200.1
Default Syslog Facility = LOG_DAEMON
Default Syslog Priority Level = LOG_CRIT
Number of Messages in Remote Log = 256
Remote Logging Local ID = MYHOSTNAME
```

#### **status**

Lists the subsystems, groups, and events that have been modified by the **display**, **nodisplay**, **trap**, **notrap**, **trace**, **notrace**, **remote**, and **noremove** commands.

#### **Example:**

```
list status
```

```
Subsystem:          TKR
Disp Levels:        STANDARD
Trap levels:        none
Trace levels:        none
```

## ELS Configuration Commands (Talk 6)

```
Remote levels:          ERROR INFO TRACE
Syslog Facility/Level: LOG_USER LOG_INFO

Group      Disp      Trap      Trace      Remote
Mygroup    Unset    Unset    Unset     On
Syslog Facility/Level: LOG_DAEMON LOG_CRIT

Event      Disp      Trap      Trace      Remote
IP.007     Unset    Unset    Unset     On
Syslog Facility/Level: LOG_CRON LOG_NOTICE
```

**Note:** Not only is remote logging enabled, but the display includes the Syslog Facility/Level values for each subsystem, group, and event. Ranges of events are listed as individual events.

### subsystem

Lists names, events, and descriptions of all subsystems.

(Example output from a **list subsystem** command can be found beginning on page 170.)

### subsystem *subsystem*

Lists all events in a specified subsystem.

#### Example:

```
list subsystem gw
```

```
Event      Level      Message
GW.001     ALWAYS    Copyright 1984 Mass Institute of Technology
GW.002     ALWAYS    Portable CGW %s Rel %s strt d
GW.003     ALWAYS    Unus pkt len %d nt %d int %s/%d
GW.004     ALWAYS    Sys %s q adv alloc %d excd %d
GW.005     ALWAYS    Bffrs: %d avail %d idle fair %d low %d
GW.006     C-INFO    Pkt frm nt %d int %s/%d for uninit prt, disc
GW.007     C-INFO    Ip err %x nt %d int %s/%d
GW.008     U-INFO    Ip ovfl nt %d int %s/%d, disc
GW.009     UI-ERROR  Nt dwn ip rst rt nt %d int %s/%d
GW.010     UI-ERROR  Ip q len %d no ip buf nt %d int %s/%d
GW.011     U-INFO    Op err %x hst %wo nt %d int %s/%d
GW.012     U-INFO    Op err cnt excd hst %wo nt %d int %s/%d
GW.013     U-INFO    Rtrns cnt excd hst %wo nt %d int %s/%d
GW.014     UI-ERROR  Nt dwn op rst rt nt %d int %s/%d
GW.015     UI-ERROR  Nt dwn to hst %wo nt %d int %s/%d
GW.016     U-INFO    Op ovfl to hst %wo nt %d int %s/%d
GW.017     UE-ERROR  Intfc hdw mssng nt %d int %s/%d
GW.018     U-TRACE   Strt nt slf tst nt %d int %s/%d
GW.019     C-INFO    Slf tst nt %d int %s/%d
GW.020     U-TRACE   Nt pss slf tst nt %d int %s/%d
GW.021     UE-ERROR  Nt up nt %d int %s/%d
GW.022     U-TRACE   Nt fld slf tst nt %d int %s/%d
```

### subsystems all

Lists all events in all subsystems.

### trace-status

Displays information on the status of packet tracing, including configuration and run-time information.

#### Example:

```
list trace-status
```

```
----- Configuration -----
Trace Status:ON  Wrap Mode:ON  Decode Packets:ON  HD Shadowing:ON
RAM Trace Buffer Size:100000  Maximum Trace Buffer File Size:10000000
Max Packet Bytes Trace:256  Default Packet Bytes Traced:100
Trace File Record Size:2048  Stop Trace Event: TCP.013
Maximum Hours to HD Shadow: 1
```

## Nodisplay

Use the **nodisplay** command to select and turn off messages displaying on the console.

## ELS Configuration Commands (Talk 6)

### Syntax:

**nodisplay**                    event. . .  
                                  group . . .  
                                  range . . .  
                                  subsystem . . .

**event** *subsystem.event#*

Suppresses the displaying of a specified event (*subsystem.event#*).

**group** *groupname*

Suppresses the displaying of messages that were previously added to the specified group (*groupname*).

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Suppresses the displaying of a range of messages for the specified subsystem.

### Example:

```
nodisplay range gw 19 22
```

Suppresses the display of events gw.19, gw.20, gw.21, and gw.22.

**subsystem** *subsystemname*

Suppresses the displaying of messages associated with the specified subsystem.

## Noremote

Use the **noremote** command to suppress the logging of events to a remote workstation based on event number, group, range of events, or subsystem.

**Note:** With the **noremote** command, there is usually no need to specify a *syslog\_facility* and *syslog\_level*, such as there is with the **remote** command. However, for **noremote subsystem** command, there exists the option of selectively suppressing specific message levels (for example, “error” only or “trace” only) rather than turning them all off. (If you do not specify any particular message level, “all” is assumed). Additionally, with the **noremote subsystem** command, you can set a *syslog\_facility* and *syslog\_level* for any remaining message levels that have not been turned off.

### Syntax:

**noremote**                    event . . .  
                                  group . . .  
                                  range . . .  
                                  subsystem . . .

**event** *subsystem.event#*

Suppresses the remote logging of messages for the specified event.

**group** *group.name*

Suppresses the remote logging of messages that were previously added to the specified group (*group.name*).

## ELS Configuration Commands (Talk 6)

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Suppresses the remote logging of a range of messages for the specified subsystem.

**Example:**

```
noremove range gw 19 22
```

Suppresses the remote logging of events gw.019, gw.020, gw.021, and gw.022

**subsystem** *subsystem.name [syslog\_facility syslog\_level]*

Suppresses the remote logging of messages associated with the specified subsystem (*subsystem.name*).

**Example 1:**

```
noremove subsystem tkr
```

Suppresses the remote logging of all “tkr” messages.

**Example 2:**

```
ELS config> noremove subsystem tkr info
ELS config> SYSLOG FACILITY[LOG_USER]?
ELS config> SYSLOG LEVEL[LOG_INFO]?
```

In this example, “LOG\_USER” and “LOG\_INFO” were the values last picked for subsystem TKR. The command specified turns off the remote logging for subsystem TKR only for messages coded for “info”. Because *syslog\_facility* and *syslog\_level* was not specified, the software prompts for *syslog\_facility* and *syslog\_level*. If you enter another value at the prompts, that value will replace *syslog\_facility* and *syslog\_level* for the remaining remote-logged messages for the TKR subsystem.

Use the **list all** or **list status** commands to display what you have set with the **noremove** and **remove** commands.

For more information about *syslog\_facility* and *syslog\_level* see “Remote” on page 153.

## Notrace

Disables packet trace for the specified event/range/subsystem/group.

**Syntax:**

```
notrace                event . . .
                        group . . .
                        range . . .
                        subsystem . . .
```

**event** *subsystem.event#*

Suppresses the sending of packet trace data for the specified event#

**group** *groupname*

Suppresses the sending of packet trace data that was previously added to the specified group (groupname).

## ELS Configuration Commands (Talk 6)

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Disables the sending of packet trace data for a range of messages for the specified subsystem.

**Example:**

```
trace range gw 19 22
```

Suppresses the sending of packet trace data for events gw.19, gw.20, gw.21, and gw.22.

**subsystem** *subsystemname*

Suppresses the sending of packet trace data for the specified subsystem (*subsystemname*).

## Notrap

Use the **notrap** command to select and turn off messages so that they are no longer sent to a network management workstation in SNMP traps.

**Syntax:**

```
notrap                event . . .  
                        group . . .  
                        range . . .  
                        subsystem . . .
```

**event** *subsystem.event#*

Suppresses the sending of the specified message in an SNMP trap (*subsystem.event#*).

**group** *groupname*

Suppresses the sending of messages in SNMP traps that were previously added to the specified group (*groupname*).

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Suppresses the sending of messages for the events in the specified range for the specified subsystem in SNMP traps.

**Example:**

```
notrap range gw 19 22
```

Suppresses the sending of messages for events gw.19, gw.20, gw.21, and gw.22 in SNMP traps.

**subsystem** *subsystemname*

Suppresses the sending of messages in SNMP traps that are associated with the specified subsystem.

## Remote

Use the **remote** command to select the events to be logged to a remote workstation by event number, range of events, group, or subsystem.

### Syntax:

```
remote                event . . .
                        range . . .
                        group . . .
                        subsystem . . .
```

**event** *subsystem.event# syslog\_facility syslog\_level*

Causes the specified event to be logged remotely. Syslog facility and level values are used by the syslog daemon in the remote workstation to determine where to log the messages. This value overrides the default values that are set with the **set facility** and **set level** commands.

*syslog\_facility*

```
log_auth
log_authpriv
log_cron
log_daemon
log_kern
log_lpr
log_mail
log_news
log_syslog
log_user
log_uucp
log_local0-7
```

*syslog\_level*

```
log_emerg
log_alert
log_crit
log_err
log_warning
log_notice
log_info
log_debug
```

These values do NOT have any particular association with any daemons on the IBM 2216. They are merely identifiers which are used by the syslog daemon on the remote workstation.

**range** *subsystemname first\_event\_number last\_event\_number syslog\_facility syslog\_level*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

## ELS Configuration Commands (Talk 6)

Causes the events in the specified range for the specified subsystem to be remotely logged based on the *syslog\_facility* and *syslog\_level* values. See “the remote event command” on page 153.

### Example:

```
remote range gw 19 22 log_user log_info
```

Causes the event gw.19, gw.20, gw.21, and gw.22 to be logged remotely on the *syslog\_facility* value of log\_user and the *syslog\_level* value of log\_info.

**group** *group.name syslog\_facility syslog\_level*

Allows events belonging to the specified group to be logged remotely based on the *syslog\_facility* and *syslog\_level* values. See “the remote event command” on page 153.

**subsystem** *subsystem.name message\_level syslog\_facility syslog\_level*

Where *subsystem.name* is the name of the subsystem and *message\_level* is the level of messages selected in the subsystem.

Causes the events within the specified *subsystem.name* whose *message\_level* agrees with the specified *message\_level* to be logged remotely at the files based on the *syslog\_facility* and *syslog\_level* values. See “the remote event command” on page 153.

*Message\_level* is a value such as “ALL,” “ERROR,” “INFO,” or “TRACE”. See “Logging Level” on page 129. The value specified in the **remote** command must agree with the value as coded on the particular event within the subsystem, or that event within the subsystem will not be remotely logged.

### Example:

```
remote subsystem ETH all log_user log_info
```

In the above example, all messages in subsystem ETH (“all” includes any messages coded for “error,” “info,” or “trace”) will be logged remotely based on log\_user and log\_info values at the remote host.

Use the **list all** or **list status** commands to display what you have set with the **noremove** and **remote** commands.

## Set

Use the **set** command to set the maximum number of tags per second, the timestamp feature, or to set tracing options.

### Syntax:

```
set                               pin . . .  
                                   remote-logging . . .  
                                   timestamp . . .  
                                   trace . . .
```

**pin** *max\_traps*

Use the **set pin** command to set the pin parameter to the maximum number of traps that can be sent on a per-second basis. Internally, the pin resets every tenth of a second. (One tenth of the number (*max\_traps*) is sent every tenth of a second.)



### remote-logging

Use the **set remote-logging** command to configure remote logging options. When these options are configured from the monitoring environment, the changes take effect immediately, and return to their previously configured settings when the device is rebooted.

#### Syntax:

```

set remote-logging      on
                        off
                        facility . . .
                        level . . .
                        no-msgs
                        remote_ip_addr . . .
                        source_ip_addr ...
                        local_id
  
```

**on** Turns remote logging on. Remote logging is now enabled to allow any messages selected by the **remote** command to be actively logged.

**off** Turns remote logging off. All messages selected by the 'remote' command will be prevented from being logged.

#### facility

Specifies a value that, in combination with the *level* value, is used by the syslog daemon in the remote workstation to determine where to log messages. This value is used for all remotely-logged ELS messages unless you specify a different value for a particular ELS event, range, group, or subsystem with the **remote** command.

These are all possible syslog facility values:

```

log_auth
log_authpriv
log_cron
log_daemon
log_kern
log_lpr
log_mail
log_news
log_syslog
log_user
log_uucp
log_local0-7
  
```

**level** Specifies a value that, in conjunction with the *facility* value, is used by the syslog daemon in the remote workstation to determine where to log messages. This value is used for all remotely-logged ELS messages unless you specify a different value for a particular ELS event, range, group, or subsystem with the **remote** command.

These are all possible syslog level values:

```

log_emerg
log_alert
log_crit
log_err
  
```

## ELS Configuration Commands (Talk 6)

log\_warning

log\_notice

log\_info

log\_debug

### **no-msgs**

Specifies the number of messages in the buffer for the remote log before log wraps.

### **remote\_ip\_addr**

This is an ip address of the form xxx.xxx.xxx.xxx where xxx can be any integer 0 to 255. It represents the ip address of the remote host where the log files reside.

### **source\_ip\_addr**

This is an ip address of the form xxx.xxx.xxx.xxx where xxx can be any integer 0 to 255.

You should use an IP address that is configured in the 2216 for easier identification when the IP address or the hostname is shown in the remotely-logged ELS message. You should also verify that this IP address is quickly resolved to a hostname by the name server, or at least that the name server responds quickly with "address not found."

To determine that the IP address resolves properly enter the **host** command on your workstation as shown:

```
workstation>host 5.1.1.1
host: address 5.1.1.1 NOT FOUND
workstation>
```

If the response takes more than 1 second, select an IP address that resolves more quickly.

### **local\_id**

This is any character string of up to 32 characters, which is included in the logged message at the remote file and can help identify which machine logged the message.

### **timestamp [timeofday or uptime or off]**

Allows you to turn on message timestamping so that either the time of day or uptime (number of hours, minutes, and seconds, but no date, since the device was last initialized) appears next to each message. Set timestamp can also be turned off.

Use the **set timestamp** command to enable one of the following timestamp options.

#### **timeofday**

Adds an HH:MM:SS prefix to each ELS message indicating the time of the occurrence during a 24-hour day.

#### **uptime**

Adds an HH:MM:SS prefix to each ELS message indicating the time of the occurrence during a 100-hour cycle. After 100 hours of uptime, the uptime counter returns to zero to begin another 100-hour cycle.

**off** Turns off the ELS timestamp prefix.

**trace** Use the **set trace** command to configure tracing options. If you configure

## ELS Configuration Commands (Talk 6)

tracing options from the monitoring environment, the changes take effect immediately. They return to their previously configured settings when the device is rebooted.

**Note:** Tracing should be used only under the direction of trained support personnel. Tracing, especially when used with disk-shadowing enabled, uses device resources and can impact overall performance and throughput.

### Syntax:

**set trace**  
decode  
default-bytes-per-pkt  
disk-shadowing  
max-bytes-per-pkt  
memory-trace-buffer-size  
off  
on  
reset  
stop-event  
wrap-mode

#### **decode** *off/on*

Turns packet decoding on or off. Packet decoding is not supported by all components.

#### **default-bytes-per-pkt** *bytes*

Sets the default number of bytes traced. This value is used if a value is not specified by the component doing the tracing.

#### **disk-shadowing** **[[off or on] or record-size or time-limit or delete-file or max-file-size]**

Turns disk shadowing on or off, sets the maximum trace file size, or sets the maximum time for disk-shadowing traces.

##### **[off or on]**

Turns disk shadowing on or off. If disk shadowing is enabled, trace records are copied to the hard disk. Once a traced record is copied to the hard disk, it can no longer be viewed from the monitoring.

**Note:** Disk shadowing should be set to OFF whenever the WRITE, TFTP software, RETRIEVE system dump, or COPY software commands are issued.

##### **disk-shadowing delete-file**

Deletes the trace file.

##### **disk-shadowing max-file-size** *Mbytes*

Sets the maximum file size for the trace file.

**Valid Values:** 1 MB to 16 MB

**Default Value:** 10

##### **disk-shadowing record-size** *bytes*

Sets the record size for trace file records:

**Valid Values** 1024, 2048, or 4096 bytes

**Default** 2048 bytes

## ELS Configuration Commands (Talk 6)

### Notes:

1. If a trace file already exists, "Cannot change Record Size without first deleting the existing Trace File" is displayed and record size is not changed.
2. If you configure a record size and a trace file already exists, the trace will use the record size of the existing file.

### **disk-shadowing time-limit** *hours*

Sets the maximum time for disk-shadowing of traces:

**Valid Values** 1 - 72 hours

**Default** 24 hours

**Note:** Disk shadowing stops (tracing continues) after this time has elapsed. The actual time is reset to 0 when disk shadowing is turned on again.

### **max-bytes-per-pkt** *bytes*

Sets the maximum number of bytes traced for each packet.

### **memory-trace-buffer-size** *bytes*

Sets the size, in bytes, of the RAM trace buffer.

**Valid Values:** 0,  $\geq 10,000$

**Default Value:** 0

**off** Disables packet tracing.

**on** Enables packet tracing.

**reset** Clears the trace buffer and resets all associated counters.

### **stop-event** *event id*

Stops tracing when an event (event id) occurs. Enter either an ELS event id (for example: TCP.013) or "None". "None" is the default. Tracing stops only if the display of the particular ELS event is enabled.

When a stop-event occurs, an entry is written to the trace buffer. The **view** command for this trace entry will display "Tracing stopped due to ELS Event Id: TCP.013".

After tracing stops due to a stop-event, you must re-enable tracing with the **set trace on** command. (A restart will also re-enable tracing if enabled from the ELS Config> prompt.)

### **wrap-mode** [**off** or **on**]

Turns the trace buffer wrap mode on or off. If wrap mode is on and the trace buffer is full, previous trace records will be overwritten by new trace records as necessary to continue tracing.

## Trace

Enables packet trace for the specified event/range/subsystem/group. When the **trace** command is used from the ELS Config> prompt, the changes become part of the configuration, and a reboot is required to activate the changes.

### Syntax:

**trace** event . . .

## ELS Configuration Commands (Talk 6)

group . . .  
range . . .  
subsystem . . .

**event** *subsystem.event#*

Causes the specified trace event (*subsystem.event#*) to be displayed on the system monitoring.

**group** *groupname*

Allows trace events that were previously added to the specified group to be displayed on the device monitoring.

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Causes the trace events in the specified range for the specified subsystem to be displayed on the system monitoring.

**Example:**

```
trace range gw 19 22
```

Causes the trace events gw.19, gw.20, gw.21, and gw.22 to be displayed on the system monitoring.

**subsystem** *subsystemname*

Allows trace events associated with the specified subsystem to be displayed on the device monitoring.

## Trap

Use the **trap** command to select the message to be sent to the remote SNMP network management workstation. A remote SNMP network management workstation is an IP host in the network acting as an SNMP manager.

**Syntax:**

trap event . . .  
group . . .  
range . . .  
subsystem . . .

**event** *subsystem.event#*

Causes the specified message (*subsystem.event#*) to be sent to a network management workstation in an SNMP trap.

**group** *groupname*

Allows messages that were previously added to the specified group to be sent to a network management workstation in an SNMP trap.

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

## ELS Configuration Commands (Talk 6)

Causes the messages that are in the specified range for the specified subsystem to be sent to a network management workstation in an SNMP trap.

**Example:**

```
trap range gw 19 22
```

Causes the messages in events gw.19, gw.20, gw.21, and gw.22 to be sent to a network management workstation in an SNMP trap.

**subsystem** *subsystemname*

Allows messages associated with the specified subsystem to be sent to a management station in an SNMP trap.

**Note:** Messages for the IP, ICMP, ARP and UDP subsystems cannot be sent in SNMP traps because these areas are or may be used in the process of sending the SNMP trap. This could lead to an infinite loop of traffic putting an undue strain on the device.

## ELS Net Filter Configuration Commands

ELS net filters give you the capability of looking only at ELS messages with certain net numbers and discarding other ELS messages.

When you create a filter, you specify the subsystem, event, or range of events to which the filter applies. You also specify the queue (for example, "DISPLAY", "TRAP", "TRACE", or "REMOTE-LOGGING"). Finally, you specify the net number (or range of net numbers) that you want to filter.

When you enable the filter, messages that have been turned on by the ELS commands are subject to filtering. The filter allows only messages with the specified net numbers. The filter causes the device to discard messages that do not contain the specified net numbers.

By reducing the number of ELS messages sent, you can more easily locate messages for the interfaces in which you are interested.

This section describes the commands to configure the ELS net filters. To configure these filters, enter the **filter net** command at the ELS> prompt. Then, enter the configuration commands at the ELS Filter net> prompt.

Table 16. ELS Net Filter Configuration Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Create	Creates a filter and assigns it a number. A maximum of 64 filters is allowed.
Delete	Deletes a specified filter number or all filters.
Disable	Disables a specified filter number or all filters.
Enable	Enables a specified filter number or all filters.
List	Lists a specified filter number or all filters.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### Create

Use the **create** command to create an ELS net filter.

#### Syntax:

```
create queue                event event_name net#_start net#_end
                                _range event_range net#_start net#_end
                                _subsystem subsystem_name net#_start net#_end
```

**queue** The queue for which you are setting the filter. The valid queues are:

- Display
- Trace
- Trap
- Remote

**event** *event\_name net#\_start net#\_end*

Specifies the event and net numbers that you are filtering.

If you specify *net#\_start* and *net#\_end* as the same number, you are filtering on a single net number.

The command **create trap event GW.009 2 10** filters traps for message GW.009 for net numbers 2 through 10.

**range** *event\_range net#\_start net#\_end*

Specifies the range of ELS messages and net numbers that you are filtering.

If you specify *net#\_start* and *net#\_end* as the same number, you are filtering on a single net number.

The command **create remote range ipx 19 22 3 6** filters all ipx messages beginning with IPX.019 and ending with IPX.022 for net numbers 3 through 6 for remote logging.

**subsystem** *subsystem\_name net#\_start net#\_end*

Specifies the subsystem and net numbers that you are filtering.

If you specify *net#\_start* and *net#\_end* as the same number, you are filtering on a single net number.

The command **create display subsys ip 1 1**, filters all ELS messages for the ip subsystem that contain net number 1 to the display. All other ip subsystem messages are discarded.

### Delete

Use the **delete** command to delete a specific ELS filter or all ELS filters.

#### Syntax:

```
delete                all
                        filter filter#
```

**all** Deletes all currently configured filters.

**filter** *filter#*

Deletes the filter specified by *filter#*. Use the **list** command to obtain the number for the filter you want to delete.

## ELS Configuration Commands (Talk 6)

### Disable

Use the **disable** command to disable a specific ELS filter or all ELS filters.

#### Syntax:

```
disable                all
                        filter filter#
```

**all** Disables all currently configured filters.

**filter** *filter#*

Disables the filter specified by *filter#*. Use the **list** command to obtain the number for the filter you want to disable.

### Enable

Use the **enable** command to enable a specific ELS filter or all ELS filters.

#### Syntax:

```
enable                all
                        filter filter#
```

**all** Enables all currently configured filters.

**filter** *filter#*

Enables the filter specified by *filter#*. Use the **list** command to obtain the number for the filter you want to enable.

### List

Use the **list** command to list a specific ELS filter or all ELS filters.

#### Syntax:

```
list                  all
                        filter filter#
```

**all** Lists all currently configured filters.

**filter** Lists the filter specified by *filter#*.

## ELS Message Buffering Configuration Commands

Table 17 describes the commands available at the ELS Config Advanced> prompt.

Table 17. ELS Message Buffering Configuration Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
List	Displays the configuration settings for message buffering.
Log	Enables logging of selected messages to the message buffer.
Nolog	Turns off logging of selected messages to the message buffer.
Set	Sets the size of the message buffer, the wrapping mode, whether logging occurs, which event will end message buffering, and what the system does when message buffering is stopped by an event.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.



### List

Use the **list** command to list the ELS message buffering configuration.

#### Syntax:

```
list status
```

#### Example:

```
ELS Config Advanced> list status
-----Configuration-----
Logging Status:  OFF      Wrap Mode:  ON  Logging Buffer Size:  8500  Kbytes
Stop-Event:     APPN.2    Stop-String:  netdn for intf 6
Additional Stop-Action:  NONE
```

See “Set” on page 164 for a description of the commands that change the values in the display.

### Log

Use the **log** command to select which messages will be logged to the message buffer.

#### Syntax:

```
log event
      group
      range
      subsystem
```

**event** *subsystem.event#*

Causes the specified message (*subsystem.event#*) to be logged to the message buffer.

**group** *groupname*

Allows messages that were previously added to the specified group to be logged to the message buffer.

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Causes the messages that are in the specified range for the specified subsystem to be logged to the message buffer.

#### Example:

```
log range gw 19 22
```

Causes the messages in events gw.19, gw.20, gw.21, and gw.22 to be logged to the message buffer.

**subsystem** *subsystemname*

Allows messages associated with the specified subsystem to be logged to the message buffer.

### Nolog

Use the **nolog** command to remove messages from the defined list of messages that are logged to the message buffer.

#### Syntax:

## ELS Configuration Commands (Talk 6)

**nolog**                                    **event**  
   **group**  
   **range**  
   **subsystem**

**event** *subsystem.event#*

Causes the specified message (*subsystem.event#*) not to be logged to the message buffer.

**group** *groupname*

Allows messages that were previously added to the specified group not to be logged to the message buffer.

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Causes the messages that are in the specified range for the specified subsystem not to be logged to the message buffer.

**Example:**

```
log range gw 19 22
```

Causes the messages in events gw.19, gw.20, gw.21, and gw.22 not to be logged to the message buffer.

**subsystem** *subsystemname*

Allows messages associated with the specified subsystem not to be logged to the message buffer.

### Set

Use the **set** command to configure various ELS message buffering options.

#### Syntax:

**set**                                    **buffer-size** *Kbytes*  
   **logging** [**on** or **off**]  
   **stop action** . . .  
   **stop event** *subsystem.event#*  
   **stop string** *text*  
   **wrap on** or **off**]

**buffer-size** *Kbytes*

Specifies the size, in kilobytes, of the message buffer that the system should allocate. The **mem** command displays this memory as Never Alloc. Setting this value too high could prevent the device from operating correctly after a reboot because of insufficient memory for protocols and features.

**Valid values:** 0 KB to 60% of the memory available on the device.

**Default value:** 0 (no message buffering)

**Note:** You must allocate a buffer with this command before you can set logging on.

### logging [on or off]

Specifies whether message buffering will occur. This command will not take affect until you allocate a buffer using the **set buffer-size** command. The default is off.

### stop action [appn-dump or disk-offload or none or system-dump]

Specifies the additional action the system takes when the “stop event” (and if specified, the “stop string”) occurs. The actions are:

#### appn-dump

Dumps the APPN protocol, if it is active. The APPN dump will indicate that the dump was taken as the result of a stop action.

#### disk-offload

Writes a formatted version of the buffer to a file on the hard drive . If the file already exists, the new file replaces it. You can then use the **tftp file** monitoring command to send the file to a remote host.

**none** No other action is taken after logging stops.

#### system-dump

Dumps the entire system. The system dump will indicate that the dump was taken as the result of a stop action.

**Default value:** none

### stop event [*subsystem.event#* or none]

Specifies the event (*subsystem.event#*) that stops logging. If you have specified a stop string, the text in the stop string must also match. When the stop event occurs:

1. If NO stop action has been specified (a value of *none*), the next five ELS messages are logged. However, if a stop action (a value other than *none*) has been specified, no additional ELS messages get logged.
2. Logging stops.
3. The system performs the specified “stop action.”

Logging remains stopped until the next time you issue the **set logging on** command or reboot the device.

If you do not specify the stop event when you enter the command, the system prompts you to enter the stop event. Specifying **none** disables the stop event function.

**Default value:** none

### stop string *text* or none

Specifies the string to be used in conjunction with the “stop event” to stop logging. If you have not specified a stop event, the system ignores the “stop string.”

*Text* can be any ASCII string up to 32 characters in length. If you do not specify *text* when you enter the command, the system will prompt you for the string. Entering **none** clears the “stop string.”

**Default value:** none

### wrap [on or off]

Specifies whether to stop the log when the buffer is full (off) or to log the new messages at the beginning of the buffer (on).

**Default value:** on

## Entering and Exiting the ELS Operating Environment

The ELS monitoring environment (available from the GWCON process) is characterized by the ELS> prompt. Commands entered at this prompt modify the current ELS parameter settings. These commands are described “Chapter 11. Configuring and Monitoring the Event Logging System (ELS)” on page 145.

To enter the ELS monitoring environment from OPCON:

1. Enter the **console** command.

\* console

The monitoring displays the GWCON prompt (+). If the prompt does not appear when you first enter GWCON, press **enter**.

2. At the GWCON prompt, enter the following command to access ELS:

+ event

The monitoring displays the ELS monitoring prompt (ELS>). Now, you can enter ELS monitoring commands.

To leave the ELS monitoring environment, enter the **exit** command.

## ELS Monitoring Commands

This section summarizes and then explains all the ELS monitoring commands. After accessing the ELS Monitoring environment, you can enter ELS monitoring commands at the ELS> prompt.

Table 18. ELS Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Advanced	Places you in the advanced configuration environment in which you can configure message buffering.
Clear	Resets to zero the counts of messages associated with specified events, groups, or subsystems.
Display	Enables message display on the console.
Exit	Exits the ELS console process and returns the user to GWCON.
Filter	Filter ELS messages based upon the net number.
List	Lists information on ELS settings and messages.
Nodisplay	Disables message display on the console.
Noremote	Disables remote logging to file at remote workstation.
Notrace	Disables trace event display on the console.
Notrap	Keeps messages from being sent out in SNMP traps to the network management workstation.
Packet-trace	Provides an enhanced central environment for setting and listing active packet tracing parameters.
Remote	Allows messages to be logged at a file on a remote workstation.
Remove	Frees up memory by erasing stored information.
Restore	Clears current settings and reloads initial ELS configuration.
Retrieve	Reloads the saved ELS configuration.
Save	Stores the current configuration.
Set	Sets the pin parameter and the timestamp feature.
Statistics	Displays available subsystems and pertinent statistics.
Trace	Enables trace event display on the console.

Table 18. ELS Monitoring Command Summary (continued)

Command	Function
Trap	Allows messages to be sent to a network management workstation in SNMP traps.
View	Allows viewing of traced packets.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Advanced

Use the **advanced** command to enter the advanced monitoring environment. In this environment you change message buffering operation.

#### Syntax:

**advanced**

### Clear

Use the **clear** command to reset to zero the counts of the display, trace, trap, or remote commands as they relate to specific events, groups or subsystems.

#### Syntax:

```
clear                event . . .
                        group . . .
                        subsystem . . .
```

#### **event** *subsystem.event#*

Resets the count of events to zero for displaying, trapping, tracing or remote logging of the specified event (*subsystem.event#*).

#### **group** *group.name*

Resets the count of events to zero for displaying, trapping, tracing or remote logging of the specified group (*group.name*).

#### **subsystem** *subsystem.name*

Resets the count of events to zero for displaying, trapping, tracing or remote logging of the specified subsystem (*subsystem.name*).

### Display

Use the display command to enable the message display on the monitoring monitor for specific events.

#### Syntax:

```
display              event . . .
                        group . . .
                        range . . .
                        subsystem . . .
```

#### **event** *subsystem.event#*

Displays messages for the specified event (*subsystem.event#*).

#### **group** *groupname*

Displays messages of a specified group (*groupname*).

#### **range** *subsystemname first\_event\_number last\_event\_number*

## ELS Monitoring Commands (Talk 5)

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event in the specified event range.

Displays a range of messages for the specified subsystem.

### Example:

```
display range gw 19 22
```

Displays events gw.19, gw.20, gw.21, and gw.22.

### **subsystem** *subsystem.name*

Displays any messages associated with the specified subsystem (*logging level*). If you do not specify a logging level, all messages for that subsystem are turned on.

## Files Trace TFTP

Use the **files trace tftp** command to retrieve trace files from the subdirectory associated with:

- The currently active bank (bank A or bank B on the hard disk)
- Bank A on the hard disk
- Bank B on the hard disk
- The trace file stored in the Network Subdirectory (if there is no active bank)

### Syntax:

```
files trace tftp          active-bank ...  
                           bank-a ...  
                           bank-b ...  
                           net-subdir ...
```

You are prompted for the *remote server IP address* and the *remote path/file name*.

### **active-bank**

Retrieves the traces file from the currently active bank

### **bank-a**

Retrieves the trace file from bank A

### **bank-b**

Retrieves the trace file from bank B

### **net-subdir**

Retrieves the trace file stored in the Network Subdirectory (if there is no active bank)

## Filter

Use the **filter** command to access the filter configuration command environment. See “ELS Net Filter Monitoring Commands” on page 188 for complete command details.

### Syntax:

```
filter                    net
```

## List

Use the **list** command to get updated information regarding ELS settings and to get listings of selected messages.

### Syntax:

```
list active . . .
      all
      event . . .
      filter-status
      groups . . .
      pin
      remote-log status
      subsystem . . .
      trace-status
```

**all** Lists all subsystems, defined groups, enabled subsystems, enabled events, and pins.

**active** *subsystem.name*

Displays the events that are active for a specific subsystem or have non-zero message counts.

### Example:

```
list active ip
Event      Active  Count  Message
IP.007          2874  %I -> %I
IP.022           13  add nt %I int %I nt %n int %s/%d
IP.036          2874  rcv pkt prt %d frm %I
IP.058           23  del nt %I rt via %I nt %n int %s/%d
IP.068          D    37  routing cache cleared
D=Display on  T=Trap on  P=Packet Trace on  F=Filter on  R=Remote Logging on
A=Advanced on
```

If Remote logging is turned on, those events displayed as active for a subsystem will have an "R" next to their name.

**event** *subsystem.event#*

Displays the logging level, the message, and the count of the specified event.

### Example:

```
list event ip.007
Level: p-TRACE
Message: source_ip address -> destination_ip_address
Active: Count: 84182
```

If Remote-logging had been activated for this event, and the *syslog\_facility* and *syslog\_level* values were *log\_daemon* and *log\_crit*, the last lines would look like:

```
Active: R count:84182
Syslog Facility: log_daemon Syslog Level: log_crit
```

**filter-status**

Lists ELS net number filters.

## ELS Monitoring Commands (Talk 5)

**groups** *group.name*

Displays the user-defined group names.

**pin** Lists the current number of ELS event messages sent per second in SNMP traps. This is a threshold value that can be used to reduce the amount of SNMP trap traffic.

**Example:**

```
list pin
```

```
Pin: 100 events/second
```

**remote-log status**

Lists the current values of the remote logging options set in the **set remote-logging** command.

**Example:**

```
list r
```

```
Remote Logging is On
Source Ip Address = 192.9.200.8
Remote Log IP Address = 192.9.200.1
Default Syslog Facility = LOG_USER
Default Syslog Priority Level = LOG_INFO
Number of Messages in Remote Log = 256
Remote Logging Local ID = SPHINX
```

**subsystem** *subsystem.name*

Lists event names, the total number of events that have occurred, and their descriptions.

**Note:** Although ELS supports all subsystems on the device, not all devices support all subsystems. See *ELS Messages* for a list of currently supported subsystems.

**subsystem** *subsystem.name*

Lists all events, logging levels, and messages for the specified subsystem.

**Example:**

```
list subsystem eth
```

```
Event      Level      Message
ETH.001    P-TRACE    brd rcv unkwn type packet_type source_Ethernet_address ->
            destination_Ethernet_address nt network
ETH.002    UE-ERROR    rcv unkwn typ packet_type source_Ethernet_address ->
            destination_Ethernet_address nt network
ETH.010    C-INFO     LLC unk SAP DSAP source_Ethernet_address ->
            destination_Ethernet_address nt network
```

**subsystem all**

Lists all events, logging levels, and messages for every event that has occurred on the device.

**trace-status**

Displays information on the status of packet tracing, including configuration and run-time information.

**Example:**

```
list trace-status
```

```
----- Configuration -----
Trace Status:ON  Wrap Mode:ON  Decode Packets:ON  HD Shadowing:ON
RAM Trace Buffer Size:100000  Maximum Trace Buffer File Size:10000000
Max Packet Bytes Trace:256  Default Packet Bytes Traced:100
Trace File Record Size:2048  Stop Trace Event: TCP.013
Maximum Hours to HD Shadow: 1
----- Run-time Status -----
Packets in RAM Trace Buffer:1  Free Trace Buffer Memory:99958
Trace Errors:0  First Packet:1  Last Packet:1
Trace Records Stored on HD:8  Trace Buffer File Size:16560
HD-Shadowing Time Exceeded? NO  Elapsed Time: 0 hr, 0 min, 10 sec
Has Stop Trace Event Occurred? NO
```



## ELS Monitoring Commands (Talk 5)

- “Trace Status” in the LIST TRACE-STATUS display will indicate OFF when STOP-ON-EVENT action occurs.
- “HD Shadowing” in the LIST TRACE-STATUS display will indicate OFF when STOP-ON-EVENT action occurs or when Time Limit is exceeded.
- “Trace Buffer File Size” will display <wrapped> when a wraparound has occurred in the trace file.
- If disk-shadowing time limit is exceeded, but there has not been a trace record written since the time expired, then “ HD-Shadowing Time Exceeded? NO < Next trace will turn it OFF>” will be displayed. When the next trace record has been written, then “HD-Shadowing Time Exceeded? YES” will be displayed.

ELS Config>**LIST TRACE** command under **talk 6** displays information similar to the following:

```
----- Configuration -----  
Trace Status:ON  Wrap Mode:ON  Decode Packets:ON  HD Shadowing:ON  
RAM Trace Buffer Size:100000  Maximum Trace Buffer File Size:10000000  
Max Packet Bytes Traced:256  Default Packet Bytes Traced:100  
Trace File Record Size:2048  Stop Trace Event: TCP.013  
Maximum Hours to HD Shadow: 1
```

## Nodisplay

Use the **nodisplay** command to select and turn off messages displaying on the console.

### Syntax:

```
nodisplay          event . . .  
                   group . . .  
                   range . . .  
                   subsystem . . .
```

### **event** *subsystem.event#*

Suppresses the displaying of messages for the specified event.

### **group** *group.name*

Suppresses the displaying of messages that were previously added to the specified group (*group.name*).

### **range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Suppresses the displaying of a range of messages for the specified subsystem.

### **Example:**

```
nodisplay range gw 19 22
```

Suppresses the display of events gw.19, gw.20, gw.21, and gw.22.

### **subsystem** *subsystem.name*

Suppresses the displaying of messages associated with the specified subsystem (*logging level*).

## ELS Monitoring Commands (Talk 5)

### NoreMOTE

Use the **noreMOTE** command to select and turn off messages logging to a remote workstation.

#### Syntax:

```
noreMOTE          event . . .  
                   group . . .  
                   range . . .  
                   subsystem . . .
```

#### **event** *subsystem.event#*

Suppresses the remote logging of messages for the specified event.

#### **group** *group.name*

Suppresses the remote logging of messages that were previously added to the specified group (*group.name*).

#### **range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Suppresses the remote logging of a range of messages for the specified subsystem.

#### **Example:**

```
noreMOTE range gw 19 22
```

Suppresses the remote logging of events gw.19, gw.20, gw.21, and g.22

#### **subsystem** *subsystem.name*

Suppresses the remote logging of messages associated with the specified subsystem (*logging level*).

#### **Example:**

```
noreMOTE subsystem tkr
```

**Note:** With noreMOTE, there is no need to specify a Syslog Facility and Level, such as there is with Remote.

Use the **list event** and **list active** commands to verify what you set with the **remote** and **noreMOTE** commands.

### Notrace

Use the **notrace** command to stop display of selected trace events at the monitoring.

#### Syntax:

```
notrace          event . . .  
                   group . . .  
                   range . . .  
                   subsystem . . .
```

**event** *subsystem.event#*

Suppresses the display of the specified tracing event.

**group** *groupname*

Suppresses the display of tracing events related to the specified group (*groupname*).

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Disables the sending of packet trace data for a range of messages for the specified subsystem.

**Example:**

```
notrace range gw 19 22
```

Suppresses the sending of packet trace data for events gw.19, gw.20, gw.21, and gw.22.

**subsystem** *subsystemname [logging-level]*

Suppresses the display of tracing events that are associated with the specified subsystem and logging level. If you do not specify a *logging-level* you suppress tracing for all logging levels for the subsystem.

**Example:**

```
notrace subsystem fr1 error
notrace subsystem fr1
```

## Notrap

Use the **notrap** command to select and turn off messages so that they are no longer sent to a network management workstation in SNMP traps.

**Syntax:**

```
notrap                event. . .
                        group . . .
                        range . . .
                        subsystem . . .
```

**event** *subsystem.event#*

Suppresses the sending of the specified message in an SNMP trap (*subsystem.event#*).

**group** *groupname*

Suppresses the sending of messages in SNMP traps that were previously added to the specified group (*groupname*).

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Suppresses the sending of messages for the events in the specified range for the specified subsystem in SNMP traps.

**Example:**

## ELS Monitoring Commands (Talk 5)

```
notrap range gw 19 22
```

Suppresses the sending of messages for events gw.19, gw.20, gw.21, and gw.22 in SNMP traps.

**subsystem** *subsystemname [logging-level]*

Suppresses the sending of messages in SNMP traps that are associated with the specified subsystem and logging level. If you do not specify a *logging-level* you suppress trapping for all logging levels for the subsystem.

**Example:**

```
notrap subsystem eth error
```

## Packet Trace

Use the **packet-trace** command to display/enable/disable packet tracing information for various subsystems.

**Syntax:**

**packet-trace**

Use the **Exit** command when you are finished using Packet Trace.

For complete command descriptions, see “Packet-trace Monitoring Commands” on page 186.

## Remote

Use the **remote** command to select the events to be logged to a remote file by event number, range of events, group, or subsystem.

**Syntax:**

```
remote                event . . .  
                        group . . .  
                        range . . .  
                        subsystem . . .
```

**event** *subsystem.event# syslog\_facility syslog\_level*

Causes the specified event to be logged remotely. Syslog facility and level values are used by the syslog daemon in the remote workstation to determine where to log the messages. This value overrides the default values that are set with the **set facility** and **set level** commands.

*syslog\_facility*

```
log_auth  
log_authpriv  
log_cron  
log_daemon  
log_kern  
log_lpr  
log_mail  
log_news  
log_syslog  
log_user
```

```

log_uucp
log_local0-7
syslog_level
log_emerg
log_alert
log_crit
log_err
log_warning
log_notice
log_info
log_debug

```

These values do NOT have any particular association with any daemons on the IBM 2216. They are merely identifiers which are used by the syslog daemon on the remote workstation.

### Example:

```
remote event gw.019 log_user log_info
```

**group** *group.name syslog\_facility syslog\_level*

Allows events belonging to the specified group to be logged remotely based on the *syslog\_facility* and *syslog\_level* values. See “the remote event command” on page 174.

**range** *subsystemname first\_event\_number last\_event\_number syslog\_facility syslog\_level*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Causes the events in the specified range for the specified subsystem to be remotely logged based on the *syslog\_facility* and *syslog\_level*. See “the remote event command” on page 174.

### Example:

```
remote range gw 19 22 log_user log_info
```

Causes the event gw.19, gw.20, gw.21, and gw.22 to be logged remotely to the files specified by the *syslog\_facility* value of log\_user and the *syslog\_level* value of log\_info.

**subsystem** *subsystem.name message\_level syslog\_facility syslog\_level*

Where *subsystem.name* is the name of the subsystem and *message\_level* is the level of messages selected in the subsystem.

Causes the events within the specified *subsystem.name* whose *message\_level* agrees with the specified *message\_level* to be logged remotely based on the *syslog\_facility* and *syslog\_level*. See “the remote event command” on page 174.

*Message\_level* is a value such as ALL, ERROR, INFO, or TRACE. See “Logging Level” on page 129. The value specified in the **remote** command must agree with the value as coded on the particular event within the subsystem, or that event within the subsystem will not be remotely logged.

### Example:

## ELS Monitoring Commands (Talk 5)

```
remote subsystem eth all log_user log_info
```

In the above example, all messages in subsystem TKR (“all” includes any messages coded for “error,” “info,” or “trace”) will be logged remotely to files specified by log\_user and log\_info at the remote host.

Use the **list event** and **list active** commands to verify what you set with the **remote** and **noremove** commands.

## Remove

Use the **remove** command to free up memory by erasing stored information. If you have previously saved the current configuration with the **save** command, remove allows you to erase the saved configuration.

**Syntax:**

remove

## Restore

Use the **restore** command to clear all current settings (except counters) and reload the initial ELS configuration. To retain the current settings, use the **save** command before restoring the initial configuration.

**Syntax:**

restore

## Retrieve

Use the **retrieve** command to reload the saved ELS configuration. If you have previously saved the current configuration with the **save** command, use **retrieve** to reload it. **Retrieve** does not erase the saved configuration after it executes. To erase the saved configuration, use the **remove** command.

**Syntax:**

retrieve

## Save

Use the **save** command to store the current configuration (except counters). **Save** does not affect the default configuration (the one you set with the configuration commands). Use **save** after modifying the configuration with the monitoring commands with the intention of saving this configuration over a restart. There can be only one saved configuration at a time. To reload the saved configuration, use the **retrieve** command.

**Syntax:**

save

## Set

Use the **set** command to set the maximum number of traps per second, to set the timestamp feature, or to set the tracing options.

**Syntax:**

set pin . . .

## ELS Monitoring Commands (Talk 5)

`_remote-logging . . .`

`_timestamp . . .`

`trace . . .`

**pin** Use the **set pin** command to set the pin parameter to the maximum number of traps that can be sent on a per-second basis. Internally, the pin resets every tenth of a second. (One tenth of the number *max\_traps* is sent every tenth of a second.)

### remote-logging

Use the **set remote-logging** command to configure remote logging options. When these options are configured from the monitoring environment, the changes take effect immediately, and return to their previously configured settings when the device is rebooted.

#### Syntax:

```
set remote-logging      on
                          off
                          facility . . .
                          level . . .
                          local_id
                          remote_ip_addr . . .
                          source_ip_addr ...
```

**on** Turns remote logging on. Remote logging is now enabled to allow any messages selected by the **remote** command to be actively logged.

**off** Turns remote logging off. All messages selected by the **remote** command will be prevented from being logged.

#### facility

Specifies a value that, in combination with the *level* value, is used by the syslog daemon in the remote workstation to determine where to log messages. This value is used for all remotely-logged ELS messages unless you specify a different value for a particular ELS event, range, group, or subsystem with the **remote** command.

These are all possible syslog facility values:

```
log_auth
log_authpriv
log_cron
log_daemon
log_kern
log_lpr
log_mail
log_news
log_syslog
log_user
log_uucp
log_local0-7
```

## ELS Monitoring Commands (Talk 5)

**level** Specifies a value that, in conjunction with the *facility* value, is used by the syslog daemon in the remote workstation to determine where to log messages. This value is used for all remotely-logged ELS messages unless you specify a different value for a particular ELS event, range, group, or subsystem with the **remote** command.

These are all possible syslog level values:

- log\_emerg
- log\_alert
- log\_crit
- log\_err
- log\_warning
- log\_notice
- log\_info
- log\_debug

### **local\_id**

Specifies a 1-32 character identifier that appears in the remote logging message that you can use to identify which machine logged a particular message.

### **remote\_ip\_addr**

This is an IP address of the remote host where the log files reside.

### **source\_ip\_addr**

Specifies the IP address of the machine that originated the message that is being remotely-logged.

You should use an IP address that is configured in the 2216 for easier identification when the IP address or the hostname is shown in the remotely-logged ELS message. You should also verify that this IP address is quickly resolved to a hostname by the name server, or at least that the name server responds quickly with "address not found."

To determine that the IP address resolves properly enter the **host** command on your workstation as shown:

```
workstation>host 5.1.1.1
host: address 5.1.1.1 NOT FOUND
workstation>
```

If the response takes more than 1 second, select an IP address that resolves more quickly.

### **timestamp**

Allows you to turn on message timestamping so that either the time of day or uptime (number of hours, minutes, and seconds, but no date, since the device was last initialized) appears next to each message, or to turn off message timestamping.

**Note:** If you turn on timestamping, you must remember to go back into the CONFIG process and set the device's date and time using the time command. Otherwise, all messages will come out with 00:00:00, or negative numbers in the hours, minutes, and/or seconds, for example 00:-4:-5.

Use the **set timestamp** command to enable one of the following timestamp options:



## ELS Monitoring Commands (Talk 5)

### **timeofday**

Adds an HH:MM:SS prefix to each ELS message indicating the time of the occurrence during a 24-hour day.

### **uptime**

Adds an HH:MM:SS prefix to each ELS message indicating the time of the occurrence during a 100-hour cycle of uptime for the device. After 100 hours of uptime, the uptime counter returns to zero to begin another 100-hour cycle.

**off** Turns off the ELS timestamp prefix.

### **Syntax:**

**set timestamp** [timeofday or uptime or off]

**trace** Use the **set trace** command to configure tracing options. When tracing options are configured from the monitoring environment, the changes take effect immediately, and return to their previously configured settings when the device is rebooted.

### **Syntax:**

**set trace** decode . . .  
default-bytes-per-pkt . . .  
disk-shadowing . . .  
max-bytes-per-pkt . . .  
memory-trace-buffer-size . . .  
off  
on  
reset  
stop-event . . .  
wrap-mode . . .

### **decode . . .**

Sets packet decode options. Packet decoding is not supported by all components.

### **exclude**

Excludes the specified frame type for decode. The possible frame types for exclusion are:

#### **lecontrol**

LE Control

**ip** IP

**arp** ARP

**ipx** IPX

#### **netbios**

NetBIOS

**bpdu** BPDU

#### **appletalk**

AppleTalk

## ELS Monitoring Commands (Talk 5)

**aarp** AppleTalk ARP

**hex** Turns off printing of hexadecimal frame data.

**summary**

Turns off printing of a one-line summary decode. A complete decode is printed.

**all** Excludes all packet types from the trace. No frame types are decoded.

**none** Excludes no packet types from the trace. *exclude all*.

**include**

Includes the specified frame type for decode. The possible frame types for inclusion are:

**lecontrol**

LE Control

**ip** IP

**arp** ARP

**ipx** IPX

**netbios**

NetBIOS

**bpdu** BPDU

**appletalk**

AppleTalk

**aarp** AppleTalk ARP

**hex** Turns on printing of hexadecimal frame data.

**summary**

Turns on printing of a one-line summary decode. A complete decode is not printed.

**all** Includes all packet types in the trace.

**none** Includes no packet types in the trace. This is the opposite of *include all*.

**off** Sets decoding off.

**on** Sets decoding on.

**Note:** The default setting is to print complete decode output for all frame types. Use the **list trace-status** command to see the current decode settings. See page 170.

**default-bytes-per-pkt** *bytes*

Sets the default number of bytes traced. This value is used if a value is not specified by the component doing the tracing.

**disk-shadowing** **[[off or on] or [delete-file or record-size or time-limit]]**

Turns disk shadowing on or off, sets the maximum trace file size, or sets the maximum time for disk-shadowing traces.

**[off or on]**

Turns disk shadowing on or off. If disk shadowing is

## ELS Monitoring Commands (Talk 5)

enabled, trace records are copied to the hard disk. Once a traced record is copied to the hard disk, it can no longer be viewed from the monitoring.

**Note:** Disk shadowing should be set to OFF whenever the WRITE, TFTP software, RETRIEVE system dump, or COPY software commands are issued.

Turns disk shadowing on or off and sets the maximum trace file size. If disk shadowing is enabled, trace records are copied to the hard disk. Once a traced record is copied to the hard disk, it is no longer viewable through the monitoring.

### **record-size** *bytes*

Sets the record size for trace file records:

**Valid Values:** 1024, 2048, or 4096 bytes

**Default:** 2048 bytes

#### **Notes:**

1. If a trace file already exists, "Cannot change Record Size without first deleting the existing Trace File" is displayed and record size is not changed.
2. If you configure a record size and a trace file already exists, the trace will use the record size of the existing file.

### **delete-file**

Deletes the trace file (in the subdirectory associated with the active bank only).

**Note:** If disk shadowing is ON when the command is issued, "Disk-shadowing must be set to OFF before trace file can be deleted" is displayed and the file is not deleted.

### **time-limit** *hours*

Sets the maximum time for disk-shadowing of traces:

**Valid Values:**

1 to 72 hours

**Default**

24

**Note:** Disk shadowing stops (tracing continues) after this time has elapsed. The actual time is reset to 0 when disk shadowing is turned on again.

### **max-bytes-per-pkt** *bytes*

Sets the maximum number of bytes traced for each packet.

### **memory-trace-buffer-size** *bytes*

Sets the size, in bytes, of the RAM trace buffer.

**Valid Values:** 0,  $\geq 10,000$

**Default Value:** 0

**off** Disables packet tracing.

## ELS Monitoring Commands (Talk 5)

**on** Enables packet tracing.

**reset** Clears the trace buffer and resets all associated counters.

### **stop-event** *event id*

Stops tracing when an event (event id) occurs. Enter either an ELS event id (for example: TCP.013) or "None". "None" is the default. Tracing stops only if the display of the particular ELS event is enabled.

When a stop-event occurs, an entry is written to the trace buffer. The **view** command for this trace entry will display "Tracing stopped due to ELS Event Id: TCP.013".

After tracing stops due to a stop-event, you must re-enable tracing with the **set trace on** command. (A restart will also re-enable tracing if enabled from the ELS Config> prompt.)

### **Example:**

```
set trace stop-event TCP.013
```

### **wrap-mode** *off/on*

Turns the trace buffer wrap mode on or off. When wrap mode is enabled and the trace buffer is full, previous trace records will be overwritten by new trace records as necessary to continue tracing.

## Statistics

Use the **statistics** command to display a list of all of the available subsystems and their statistics.

**Note:** The following example may not match your display exactly. The output of the command depends on the version and release of the installed software.

### **Syntax:**

#### **statistics**

### **Example:**

#### **statistics**

Subsys	Vector	Exist	String	Active	Heap
GW	105	101	3411	0	0
FLT	20	7	184	0	0
BRS	50	5	201	0	0
ARP	150	142	7030	0	0
IP	100	100	2463	2	20
ICMP	30	21	529	0	0
TCP	60	57	2420	0	0
UDP	10	6	179	0	0
BTP	40	13	695	0	0
RIP	30	22	474	0	0
OSPF	80	73	2859	0	0
MSPF	40	17	593	0	0
TFTP	35	29	819	0	0
SNMP	30	28	821	0	0
DVM	30	21	589	0	0
DN	140	115	5842	0	0
XN	35	21	780	0	0
IPX	110	110	4705	0	0
CLNP	80	58	1763	0	0
ESIS	40	24	716	0	0
ISIS	80	58	2422	0	0
DNAV	50	26	1314	0	0
AP2	80	70	1755	0	0
ZIP2	60	51	1859	0	0
R2MP	50	38	1185	0	0
VIN	90	79	3159	0	0

## ELS Monitoring Commands (Talk 5)

SRT	120	94	5040	0	0
STP	60	32	1590	0	0
BR	50	30	1616	0	0
SRLY	30	28	1409	0	0
ETH	60	47	1098	0	0
SL	50	35	584	0	0
TKR	60	45	2031	0	0
X25	70	53	1909	0	0
FDDI	30	27	1155	0	0
SDLC	100	95	4263	0	0
FRL	130	97	6068	0	0
PPP	190	186	6394	0	0
X251	50	16	546	0	0
X252	50	34	996	0	0
X253	50	42	1649	0	0
ISDN	50	43	1994	0	0
IPPN	20	4	132	0	0
WRS	40	33	1938	0	0
LNМ	70	60	3137	0	0
LLC	170	168	9840	0	0
BGP	80	74	2477	0	0
MCF	15	9	244	0	0
DLS	500	497	24340	0	0
V25B	30	28	1058	0	0
BAN	30	29	1223	0	0
COMP	80	26	1050	0	0
NBS	100	50	3029	0	0
ATM	300	216	10808	0	0
LEC	200	174	7258	0	0
APPN	100	28	467	0	0
ILMI	150	23	487	0	0
SAAL	30	26	621	0	0
SVC	30	26	465	0	0
LES	400	361	22333	0	0
LECS	150	145	5666	0	0
EVLOG	1	1	105	0	0
NOT	25	15	508	0	0
NHRP	250	211	8193	0	0
XTP	64	58	2271	0	0
ESC	150	67	3122	0	0
LCS	40	22	858	0	0
LSA	70	61	3506	0	0
MPC	130	30	1677	3	44
SCSP	40	34	1234	0	0
ALLC	50	36	1842	0	0
NDR	50	38	1150	0	0
MLP	100	93	4006	0	0
SEC	50	30	688	0	0
ENCR	100	4	194	0	0
PM	25	6	120	0	0
DGW	20	9	238	0	0
QLLC	55	54	2411	0	0
Total	6490	4942	215805	5	64

Maximum:7976 vector, 155 subsystem  
 Memory:71784/620 vector+ 81256/217714 data+ 64 heap=371438Subsys

### Subsys

Name of subsystem

### Vector

Maximum size of subsystem

**Exist** Number of events defined in this subsystem

**String** Number of bytes used for message storage in this subsystem

**Active** Number of active (displayed, trapped, or counted) events in the subsystem

**Heap** Dynamic memory in use by subsystem

## ELS Monitoring Commands (Talk 5)

### Trace

Use the **trace** command to select the trace events to be displayed on the system monitoring. This command provides function that is similar to the **packet trace** command described in “Packet-trace Monitoring Commands” on page 186.

#### Syntax:

```
trace                event . . .  
                    group . . .  
                    range . . .  
                    subsystem . . .
```

#### **event** *subsystem.event#*

Causes the specified trace event (*subsystem.event#*) to be displayed on the system monitoring.

#### **group** *groupname*

Allows trace events that were previously added to the specified group to be displayed on the device monitoring.

#### **range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Causes the trace events in the specified range for the specified subsystem to be displayed on the system monitoring.

#### **Example:**

```
trace range gw 19 22
```

Causes the trace events gw.19, gw.20, gw.21, and gw.22 to be displayed on the system monitoring.

#### **subsystem** *subsystemname*

Allows trace events associated with the specified subsystem to be displayed on the device monitoring.

### Trap

Use the **trap** command to select the message to be sent to the remote SNMP network management workstation. A remote SNMP network management workstation is an IP host in the network acting as an SNMP manager.

#### Syntax:

```
trap                event . . .  
                    group . . .  
                    range . . .  
                    subsystem . . .
```

#### **event** *subsystem.event#*

Causes the specified message (*subsystem.event#*) to be sent to a network management workstation in an SNMP trap.

**group** *groupname*

Allows messages that were previously added to the specified group to be sent to a network management workstation in an SNMP trap.

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Causes the messages that are in the specified range for the specified subsystem to be sent to a network management workstation in an SNMP trap.

**Example:**

```
trap range gw 19 22
```

Causes the messages in events gw.19, gw.20, gw.21, and gw.22 to be sent to a network management workstation in an SNMP trap.

**subsystem** *subsystemname*

Allows messages associated with the specified subsystem to be sent to a management station in an SNMP trap.

**Note:** Messages for the IP, ICMP, ARP and UDP subsystems cannot be sent in SNMP traps because these areas are or may be used in the process of sending the SNMP trap. This could lead to an infinite loop of traffic putting an undue strain on the device.

## View

Use the **view** command to view traced packets.

**Syntax:**

```
view                _current  
                    _first  
                    jump  
                    _last  
                    _next  
                    _prev  
                    _search ...
```

**current**

Displays the current trace packet. If the current packet is not valid, the first packet in the trace buffer is displayed.

**first** Displays the first traced packet in the trace buffer.

**jump** *n*

Displays the traced packet *n* packets ahead of or behind the current packet.

**last** Displays the last traced packet in the trace buffer.

**next** Displays the next traced packet.

**prev** Displays the previous traced packet.

## ELS Monitoring Commands (Talk 5)

### search

Displays the next traced packet that contains the specified information. You can specify the search information by:

- Hexadecimal string
- IP address
- ASCII text

## Packet-trace Monitoring Commands

This section describes the Packet-trace Monitoring commands. After accessing the Packet-trace Monitoring environment, you can enter Packet-trace Monitoring commands at the ELS Packet Trace> prompt.

Table 19. Packet Trace Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Off	Disables packet tracing.
On	Enables packet tracing. Prompts for memory trace buffer size if not previously set.
Reset	Clears the trace buffer and resets all associated counters.
Set	Configures tracing options.
Subsystems	Activates tracing for the subsystems that support packet tracing, or displays a summary.
Trace-status	Displays information on the status of packet tracing, including configuration and run-time.
View	Provides View Captured Packet Trace Buffers Console
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Off

Use the **off** command to disable packet tracing.

#### Syntax:

off

### On

Use the **on** command to enable packet tracing.

#### Syntax:

on

### Reset

Use the **reset** command to clear the trace buffer and reset all associated counters.

#### Syntax:

reset

### Set

Use the **set** command to configure tracing options.

#### Syntax:

set

decode

default-bytes-per-pkt



## ELS Monitoring Commands (Talk 5)

disk-shadowing  
max-bytes-per-pkt  
memory-trace-buffer-size  
stop-event  
wrap-mode  
exit

For an explanation of the set command, see page 179.

### Subsystems

Use the **subsystems** command to activate tracing for the subsystems that support packet tracing, or to display a summary.

#### Syntax:

subsystems                    atm  
                                  fdi  
                                  lec  
                                  summary

#### Example:

```
subsystems atm
Network number? 0
ATM Interface is selected
on | off | list [list]? on
Note that SVC uses VPI = 0, VCI = 5
and ILMI uses VPI = 0, VCI = 16
Beginning of VPI range [0]?
End of VPI range [0]?
Beginning of VCI range [0]? 16
End of VCI range [0]? 16
Tracing event ATM.88: ATM frames
```

#### Example:

```
subsystems lec
Network number? 1
ATM Emulated LAN is selected
on | off | list [list]? on
Trace which types of frames (data, control, both) [both]?
Tracing event LEC.11: data frames over ATM Forum LEC: interface 1
Tracing event LEC.12: control frames over ATM Forum LEC: interface 1
Note that if the user DISABLES and TESTS this LEC interface,
the LEC trace settings from Talk 6 Config will take effect.
```

MAC Address packet filtering can be enabled under the LEC net using the 'trace mac-address' command.

#### Example:

```
subsystems summary
Subsystems Being Traced

ATM      net number = 0, VPI Range:    0 -    0
          VCI Range:   16 -   16
LEC      net number = 1
```

### Trace-Status

Use the **trace-status** command to get updated information regarding packet trace.

#### Syntax:

## ELS Monitoring Commands (Talk 5)

### trace-status

#### Example:

```
trace-status
----- Configuration -----
Trace Status:OFF  Wrap Mode:OFF  Decode Packets:OFF  HD Shadowing:OFF
RAM Trace Buffer Size:0  Maximum Trace Buffer File Size:10000000
Max Packet Bytes Trace:256  Default Packet Bytes Traced:100
Trace File Record Size:2048  Stop Trace Event: None
Maximum Hours to HD Shadow: 24
----- Run-time Status -----
Packets in RAM Trace Buffer:0  Free Trace Buffer Memory:0
Trace Errors:0  First Packet:0  Last Packet:0
Trace Records Stored on HD:0  Trace Buffer File Size:0
HD-Shadowing Time Exceeded? NO
Has Stop Trace Event Occurred? NO
```

#### View

Use the **view** command to enter the View Captured Packet Trace Buffers Monitoring.

For an explanation of the **view** commands, see “View” on page 185.

#### Syntax:

```
view          current
              first
              jump
              last
              next
              prev
              search
              exit
```

## ELS Net Filter Monitoring Commands

This section describes explains the commands to manipulate ELS net filters. To enter the filter environment, enter the **filter net** command at the ELS> prompt. Enter the monitoring commands at the ELS Filter net> prompt.

Table 20. ELS Net Filter Monitoring Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Create	Creates a filter and assigns it a number. A maximum of 64 filters is allowed.
Delete	Deletes a specified filter number or all filters.
Disable	Disables a specified filter number or all filters.
Enable	Enables a specified filter number or all filters.
List	Lists a specified filter number or all filters.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

#### Create

Use the **create** command to create an ELS net filter.

#### Syntax:

## ELS Monitoring Commands (Talk 5)

**create** *queue* event *event\_name net#\_start net#\_end*  
*\_range event\_range net#\_start net#\_end*  
*\_subsystem subsystem\_name net#\_start net#\_end*

**queue** The queue for which you are setting the filter. The valid queues are:

- Display
- Trace
- Trap
- Remote

**event** *event\_name net#\_start net#\_end*

Specifies the event and net numbers that you are filtering.

If you specify *net#\_start* and *net#\_end* as the same number, you are filtering on a single net number.

The command **create trap event GW.009 2 10** filters traps for message GW.009 for net numbers 2 through 10.

**range** *event\_range net#\_start net#\_end*

Specifies the range of ELS messages and net numbers that you are filtering.

If you specify *net#\_start* and *net#\_end* as the same number, you are filtering on a single net number.

The command **create remote range ipx 19 22 3 6** filters all ipx messages beginning with IPX.019 and ending with IPX.022 for net numbers 3 through 6 for remote logging.

**subsystem** *subsystem\_name net#\_start net#\_end*

Specifies the subsystem and net numbers that you are filtering.

If you specify *net#\_start* and *net#\_end* as the same number, you are filtering on a single net number.

The command **create display subsys ip 1 1**, filters all ELS messages for the ip subsystem that contain net number 1 to the display. All other ip subsystem messages are discarded.

### Delete

Use the **delete** command to delete a specific ELS filter or all ELS filters.

#### Syntax:

**delete** all  
*filter filter#*

**all** Deletes all currently configured filters.

**filter** *filter#*

Deletes the filter specified by *filter#*. Use the **list** command to obtain the number for the filter you want to delete.

### Disable

Use the **disable** command to disable a specific ELS filter or all ELS filters.

#### Syntax:

**disable** all

## ELS Monitoring Commands (Talk 5)

filter *filter#*

**all** Disables all currently configured filters.

**filter** *filter#*

Disables the filter specified by *filter#*. Use the **list** command to obtain the number for the filter you want to disable.

### Enable

Use the **enable** command to enable a specific ELS filter or all ELS filters.

#### Syntax:

**enable**

all

filter *filter#*

**all** Enable all currently configured filters.

**filter** *filter#*

Enable the filter specified by *filter#*. Use the **list** command to obtain the number for the filter you want to enable.

### List

Use the **list** command to list a specific ELS filter or all ELS filters.

#### Syntax:

**list**

all

filter *filter#*

**all** Lists all currently configured filters.

**filter** *filter#*

Lists the filter specified by *filter#*.

## ELS Message Buffering Monitoring Commands

Table 21 describes the commands available at the ELS Config Advanced> prompt.

Table 21. ELS Message Buffering Monitoring Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Flush	Clears the message buffer and turns off logging to the message buffer.
List	Displays the operational settings for message buffering.
Log	Enables logging of selected messages to the message buffer.
Nolog	Turns off logging of selected messages to the message buffer.
Read-file	Reads a formatted message buffer from a file and displays it on the console.
Set	Sets the size of the message buffer, the wrapping mode, whether logging occurs, which event will end message buffering, and what the system does when message buffering is stopped by an event.
Tftp	Sends the ELS message buffer to a file at a remote host.
View	Displays all or a specific number of messages in the message buffer. You can also control how the messages scroll off the screen.
Write-buffer	Writes the ELS message buffer to the hard drive. The buffer is formatted before it is written. The file name on the hard drive is always ELSADV.LOG.

## ELS Monitoring Commands (Talk 5)

Table 21. ELS Message Buffering Monitoring Commands (continued)

Command	Function
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Flush

Use the **flush** command to set logging off, clear the messages from the buffer, and release the buffer memory for other use by the system.

#### Syntax:

**flush** buffer

### List

Use the **list** command to list the ELS message buffering configuration.

#### Syntax:

**list** status

#### Example:

```
ELS Advanced> list status
-----Configuration-----
Logging Status:  OFF      Wrap Mode:  ON      Logging Buffer Size:  8500 Kytes
Stop-Event:     APPN.2   Stop-String:  netdn for intf 6
Additional Stop-Action: APPN DUMP
-----Run-Time Status-----
Has Stop Condition Occurred ?  YES      Messages currently in buffer:  1222
```

See “Set” on page 193 for a description of the commands that change the values in the display.

### Log

Use the **log** command to select which messages will be logged to the message buffer.

#### Syntax:

**log** event  
group  
range  
subsystem

**event** *subsystem.event#*

Causes the specified message (*subsystem.event#*) to be logged to the message buffer.

**group** *groupname*

Allows messages that were previously added to the specified group to be logged to the message buffer.

**range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Causes the messages that are in the specified range for the specified subsystem to be logged to the message buffer.

## ELS Monitoring Commands (Talk 5)

### Example:

```
log range gw 19 22
```

Causes the messages in events gw.19, gw.20, gw.21, and gw.22 to be logged to the message buffer.

### **subsystem** *subsystemname*

Allows messages associated with the specified subsystem to be logged to the message buffer.

### **Nolog**

Use the **nolog** command to remove messages from the defined list of messages that are logged to the message buffer.

### Syntax:

```
nolog                event  
                        group  
                        range  
                        subsystem
```

### **event** *subsystem.event#*

Causes the specified message (*subsystem.event#*) not to be logged to the message buffer.

### **group** *groupname*

Allows messages that were previously added to the specified group not to be logged to the message buffer.

### **range** *subsystemname first\_event\_number last\_event\_number*

Where *first\_event\_number* is the number of the first event in the specified event range, and *last\_event\_number* is the number of the last event of the specified event range.

Causes the messages that are in the specified range for the specified subsystem not to be logged to the message buffer.

### Example:

```
log range gw 19 22
```

Causes the messages in events gw.19, gw.20, gw.21, and gw.22 not to be logged to the message buffer.

### **subsystem** *subsystemname*

Allows messages associated with the specified subsystem not to be logged to the message buffer.

### **Read-file**

Use the **read-file** command to read formatted ELS messages from a file on the hard drive, ELSADV.LOG, created by the **write-buffer** command.

**Note:** If you enter this command and a hard drive is not available, you will receive a message indicating the drive is unavailable.

### Syntax:

```
read-file
```

### Set

Use the **set** command to change configured ELS message buffering options.

#### Syntax:

```
set                logging [on or off]
                   stop action . . .
                   stop event subsystem.event#
                   stop string text
                   wrap [on or off]
```

#### **logging** [on or off]

Specifies whether message buffering will occur. This command will not take affect until you allocate a buffer using the **set buffer-size** command. The default is off.

#### **stop action** [**appn-dump** or **disk-offload** or **none** or **system-dump**]

Specifies the additional action the system takes when the “stop event” (and if specified, the “stop string”) occurs. The actions are:

##### **appn-dump**

Dumps the APPN protocol, if it is active. The APPN dump will indicate that the dump was taken as the result of a stop action.

##### **disk-offload**

Writes a formatted version of the buffer to a file on the hard drive . If the file already exists, the new file replaces it. You can then use the **tftp file** monitoring command to send the file to a remote host.

**none** No other action is taken after logging stops.

##### **system-dump**

Dumps the entire system. The system dump will indicate that the dump was taken as the result of a stop action.

**Default value:** none

#### **stop event** [*subsystem.event#* or **none**]

Specifies the event (*subsystem.event#*) that stops logging. If you have specified a stop string, the text in the stop string must also match. When the stop event occurs:

1. If no stop action has been specified (that is, none), the next five ELS messages are logged. However, if a stop action (other than none) has been specified, no additional ELS messages are logged.
2. Logging stops.
3. The system performs the specified “stop action.”

Logging remains stopped until the next time you issue the **set logging on** command or the device reboots.

If you do not specify the stop event when you enter the command, the system prompts you to enter the stop event. Specifying **none** disables the stop event function.

**Default value:** none

## ELS Monitoring Commands (Talk 5)

### **stop string** *text* or **none**

Specifies the string to be used in conjunction with the “stop event” to stop logging. If you have not specified a stop event, the system ignores the “stop string.”

*Text* can be any ASCII string up to 32 characters in length. If you do not specify *text* when you enter the command, the system will prompt you for the string. Entering **none** clears the “stop string.”

**Default value:** none

### **wrap** [**on** or **off**]

Specifies whether to stop the log when the buffer is full (off) or to log the new messages at the beginning of the buffer (on).

**Default value:** on

### **Tftp**

Use the **tftp** command to send the ELS message buffer to a remote host as a formatted file.

#### **Syntax:**

```
tftp buffer [formatted ] dest_ip_address dest_filename  
file dest_ip_address dest_filename
```

**buffer** [formatted ] dest\_ip\_address dest\_filename

Specifies that the ELS message buffer is to be sent to the remote host indicated by dest\_ip\_address as file dest\_filename. The buffer can be either formatted.

### **View**

Use the **view** command to view all of the messages or a specific number of messages in the message buffer.

#### **Syntax:**

```
view all [scroll/noscroll]  
last [scroll/noscroll number]
```

**all** *scroll/noscroll*

Displays all of the messages in the message buffer.

#### **[scroll]**

Specifies that the screen pauses until you hit the spacebar.

**Note:** If you are displaying a large number of messages, specify scroll so you do not miss any critical messages.

#### **noscroll**

Specifies that the messages will scroll off the screen if the number of messages exceeds the screen length.

**last** *scroll/noscroll number*

Display the last *number* messages in the message buffer.

#### **[scroll]**

Specifies that the screen pauses after displaying a full screen of messages and waits for the user to hit the space bar to get the next screen.



## ELS Monitoring Commands (Talk 5)

**Note:** If you are displaying a large number of messages, specify scroll so you do not miss any critical messages.

### **noscroll**

Specifies that the messages will continuously scroll off the screen with no scroll control until either all messages in the buffer (or the last number of messages requested) have been displayed.

### **number**

Specify a number from 1 to the total number of messages in the message buffer. To display the total number of messages in the buffer, use the **list status** monitoring command.

### **Write-buffer**

Use the **write-buffer** command to write formatted ELS messages to the hard drive .

**Note:** If you enter this command and a hard drive is not available, you will receive a message indicating the drive is unavailable.

### **Syntax:**

write-buffer

## ELS Monitoring Commands (Talk 5)

---

## Chapter 12. Configuring and Monitoring Performance

This chapter describes how to use the Performance configuration and monitor operating commands and includes the following sections:

- “Performance Overview”
- “Performance Reporting Accuracy”
- “Accessing the Performance Configuration Environment”
- “Performance Configuration Commands” on page 198
- “Accessing the Performance Monitoring Environment” on page 198
- “Performance Monitoring Commands” on page 199

---

### Performance Overview

Configuring performance allows you to monitor your CPU load. In the idle (non-work load) state, performance reflects operations that the device continuously performs as a part of managing external interfaces. The CPU load registered in the idle state is dependent upon:

- Number of protocols running.
- Number of interfaces/cards installed.
- Type of interfaces installed.

The performance function can be used as a tool for trend analysis, bottleneck evaluation, and capacity planning. By collecting the CPU utilization information on the device, a network manager can monitor:

- CPU load versus time of day.
- CPU load versus location of the device in the network.
- CPU load versus traffic throughput.
- CPU load versus user load (for example: TN3270 sessions, ISDN dial in clients)

---

### Performance Reporting Accuracy

If you request a performance analysis when the 2216 first comes online, you will see values that reflect an initialization state that has little or no network traffic, so it is of little use in helping to balance your network load.

It is best to use performance reports that are generated under normal loads after approximately 2 minutes of operation.

---

### Accessing the Performance Configuration Environment

Use the following procedure to access the Performance monitor configuration process.

1. At the OPCON prompt, enter **talk 6**. (For more detail on this command, see “What is CONFIG?” on page 63.) For example:

```
* talk 6
Config>
```

After you enter the **talk 6** command, the CONFIG prompt (Config>) displays on the terminal. If the prompt does not appear when you first enter configuration, press **enter** again.

2. At the CONFIG prompt, enter the **perf** command to get to the PERF Config> prompt.

---

# Performance Configuration Commands

To configure Performance, enter the commands at the PERF Config> prompt.

*Table 22. PERF Configuration Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Disable	Disables the collection of CPU utilization statistics or Talk 2 ELS monitor output.
Enable	Enables the collection of CPU utilization statistics or Talk 2 ELS monitor output.
List	Lists the configuration.
Set	Sets the reporting period.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## Disable

Use the **disable** command to disable collection of CPU utilization statistics and disable the talk 2 ELS monitor output.

**Syntax:**

**disable** cpu statistics  
t2 output

## Enable

Use the **enable** command to enable collection of CPU utilization statistics and enable the talk 2 ELS monitor output.

**Syntax:**

**enable** cpu statistics  
t2 output

## List

Use the **list** command to display the performance monitor configuration.

**Syntax:**

**list**

## Set

Use the **set** command to set the reporting period.

**Syntax:**

**set** *time*

**time** Specifies the short window time.

**Valid Values:** 2 - 30 seconds

**Default Value:** 5

---

## Accessing the Performance Monitoring Environment

Use the following procedure to access the Performance monitoring commands. This process gives you access to the Performance *monitoring* process.

## Performance Configuration Commands (Talk 6)

1. At the OPCON prompt, enter **talk 5**. (For more detail on this command, see “Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands” on page 109.) For example:

```
* talk 5
+
```

After you enter the **talk 5** command, the GWCON prompt (+) displays on the terminal. If the prompt does not appear when you first enter configuration, press **enter** again.

2. At the + prompt, enter the **perf** command to get you to the PERF Console> prompt.

**Example:**

```
+ perf
PERF Console>
```

---

## Performance Monitoring Commands

This section describes the Performance monitoring commands.

*Table 23. PERF Monitoring Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Clear	Clear the CPU utilization high water statistics and resets the reporting period to a new cycle.
Disable	Disables the collection of CPU utilization statistics or Talk 2 ELS monitor output.
Enable	Enables the collection of CPU utilization statistics or Talk 2 ELS monitor output.
List	Lists the configuration.
Report	Displays a report of performance statistics.
Set	Sets the reporting period.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Disable

Use the **disable** command to disable collection of CPU utilization statistics and disable the talk 2 ELS monitor output.

**Syntax:**

```
disable          cpu statistics
                   t2 output
```

### Enable

Use the **enable** command to enable collection of CPU utilization statistics and enable the talk 2 ELS monitor output.

**Syntax:**

```
enable          cpu statistics
                   t2 output
```

### List

Use the **list** command to display the performance monitor configuration.

**Syntax:**

## Performance Monitoring Commands (Talk 5)

list

### Report

Use the **report** command to display performance monitor statistics.

**Syntax:**

report

**Example:**

```
PERF Console>report
-----
KEY: SW = Short Window = 9 seconds
KEY: LW = Long Window = 9.0 minutes (60 x SW)

CPU UTIL : Most recent SW           = 38%
           Most recent LW           = 33%
           Highest for all SW's     = 92%
           Highest for all LW's     = 52%
           % of time cpu util (SW) was > 60% = 16%
           % of time cpu util (SW) was > 70% = 15%
           % of time cpu util (SW) was > 80% = 1%
           % of time cpu util (SW) was > 90% = 0%
           % of time cpu util (SW) was > 95% = 0%
-----
```

### Set

Use the **set** command to set the reporting period.

**Syntax:**

set *time*

**time** Specifies the short window time.

**Valid Values:** 2 - 30 seconds

**Default Value:** 5

---

## **Part 3. Understanding, Configuring and Operating Interfaces**





---

## Chapter 13. Getting Started with Network Interfaces

The chapters of this book describe how to configure and monitor network interfaces and link layer protocols supported by the Router. The purpose of this chapter is to give you some basic configuration and monitoring guidelines. This chapter also provides you with basic procedures and information needed for monitoring the interfaces via the GWCON **interface** command. This chapter includes the following sections:

- “Before You Continue”
- “Network Interfaces and the GWCON Interface Command”
- “Accessing Network Interface Configuration and Console Processes”
- “Accessing Link Layer Protocol Configuration and Console Processes”
- “Defining Spare Interfaces” on page 204

---

### Before You Continue

Before you continue, make sure that you have familiarized yourself with the procedures necessary for accessing the network interface configuration processes.

For more information on these procedures, refer to the sections that follow in this chapter.

---

### Network Interfaces and the GWCON Interface Command

When configuring network interfaces, you may find it necessary to display certain information about specific interfaces. While some interfaces have their own console processes for monitoring purposes, the router displays statistics for *all* installed network interfaces when you use the **interface** command from the GWCON environment. (Refer to “Interface” on page 117.)

---

### Accessing Network Interface Configuration and Console Processes

The follow references contain the background information and examples of how to access the configuration and console prompts for interfaces.

Refer to “Adding Devices” on page 15, “Accessing the Network Interface Configuration Process” on page 15, and “Accessing the Network Interface Console Process” on page 19 for complete information on accessing interface configuration and console processes. Accessing these processes allows you to change and monitor software configurable parameters for network interfaces used in your router.

---

### Accessing Link Layer Protocol Configuration and Console Processes

Refer to “Chapter 1. Getting Started” on page 3 for complete information on accessing the protocol configuration and console processes. Accessing these processes allows you to change and monitor configurable parameters for Link Layer protocols supported by your router.

### Defining Spare Interfaces

There may be occasions when you will need to define interfaces on your device that do not currently exist. You accomplish this ***dynamic reconfiguration*** of a device by defining spare interfaces while you are configuring the device and then using the console process to activate the interfaces when they are present. See “Configuring Spare Interfaces” on page 66 and “Activate” on page 110 for details.

---

## Chapter 14. Configuring IEEE 802.5 Token-Ring Network Interfaces

This chapter describes Token-Ring interfaces configuration and operational commands. It includes the following sections:

- “Accessing the Token-Ring Interface Configuration Process”
- “Token-Ring Configuration Commands”
- “Accessing the Interface Monitoring Process” on page 208
- “Token-Ring Interface Monitoring Commands” on page 209
- “Token-Ring Interfaces and the GWCON Interface Command” on page 210
- “Token-Ring Dynamic Reconfiguration Support” on page 213

---

### Accessing the Token-Ring Interface Configuration Process

To display the TKR config> prompt, enter the network command followed by the interface number of the Token-Ring interface. For example:

```
Config>network 0
Token-Ring interface configuration
TKR Config>
```

Use the **list devices** command at the Config> prompt to display a list of interface numbers configured on the router.

**Note:** Whenever you change a parameter, you must restart the router for the changes to take effect.

---

### Token-Ring Configuration Commands

This section describes the Token-Ring configuration commands. Enter the commands at the TKR config> prompt. Table 24 lists Token-Ring configuration commands.

Table 24. Token-Ring Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Displays the selected Token-Ring interface configuration.
LLC	Accesses the LLC configuration environment and subcommands.
Media	Sets the media-type as shielded or unshielded.
Packet-size	Changes packet-size defaults for all Token-Ring networks.
Set	Sets the aging timer for the RIF cache and the physical (MAC) address. Also sets full or half-duplex operational modes.
Source-routing	Enables or disables source-routing on the interface.
Speed	Sets the interface speed in Mbps.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

#### List

Use the **list** command to display the current configuration for the Token-Ring interface.

**Note:** If the MAC address is 0, the default station address is used.

## Configuring Token-Ring Network Interfaces

### Syntax:

**list**

-

### Example:

**list**

Token-Ring configuration:

```
Packet size (INFO field): 2052
Speed:                    16 Mb/sec
Media:                    Shielded

RIF Aging Timer:         120
Source Routing:          Enabled
MAC Address:              000000000000
```

### Packet size

Size of the Token-Ring packet.

**Speed** Speed of the network.

**Media** Type of media the network uses, shielded or unshielded.

### RIF Aging Timer

Amount of time that the router holds the information contained in the Routing Information Field (RIF).

### Source Routing

Status of the source-routing feature, enabled or disabled.

### MAC Address

Configured MAC address that was set with the **set physical-address** command. If all zeros are displayed, the MAC address is the default address.

## LLC

Use the **LLC** command to access the LLC configuration environment. See “LLC Configuration Commands” on page 233 for an explanation of each of these commands.

### Syntax:

**llc**

**Note:** If APPN is not included in your router software load, you will receive the following message if you try to use this command:

```
LLC configuration is not available for this network.
```

The LLC configuration environment is only available if APPN is included in the software load.

## Media

Use the **media** command to change the network media type. The default media type is STP cable. Valid media type values are shielded and unshielded. Enter the media command followed by the *media-type*.

### Syntax:

**media** *media-type*

### Example:

```
media unshielded
```

## Packet-Size

Use the **packet-size** command to change maximum packet-size for all Token-Ring networks. Enter the **packet-size** command followed by the desired number of bytes.

### Syntax:

**packet-size** *bytes*

Table 25. Token-Ring 4/16 Valid Packet Sizes

Network Data Speed	Values (# of bytes)
4 Mbps	516 to 4498 <b>Note:</b> If a value greater than 4498 is defined for a 4 Mb TR then the software will set it to 4498. If the user does not specify a value, then the default is 2052.
16 Mbps	516 to 18144 <b>Note:</b> If you do not specify a value, then the default is 2052.

**Note:** If packet sizes are increased, buffer memory requirements will also increase.

## Set

Use the **set** command to set the Routing Information Field (RIF) timer and the physical (MAC) address.

### Syntax:

**set** *physical-address*  
*rif-timer*

#### physical-address

Indicates whether you want to define a locally administered address for the Token-Ring interface's MAC sublayer address, or use the default factory station address (indicated by all zeroes). The MAC sublayer address is the address that the Token-Ring interface uses to receive and transmit frames.

**Note:** Pressing **Return** leaves the value the same. Entering **0** and pressing **Return** causes the router to use the factory station address. The default is to use the factory station address.

**Valid values:** Any 12-digit hexadecimal address.

**Default value:** burned-in address (indicated by all zeroes).

#### Example:

```
set physical-address
MAC address in 00:00:00:00:00:00 form []?
```

#### rif-timer

Sets the maximum amount of time (in seconds) that the information in the RIF is maintained before it is refreshed. The default is 120.

#### Example:

```
set rif-timer
RIF aging timer value [120]? 120
```

## Configuring Token-Ring Network Interfaces

### Source-routing

Use the **source-routing** command to enable or disable end station source routing. Source routing is the process by which end stations determine the source route to use to cross source routing bridges. Source routing allows the IP, IPX, and AppleTalk Phase 2 protocols to reach nodes on the other side of the source routing bridge.

This switch is completely independent of whether this interface is providing source routing via the SRT forwarder. The default setting is enabled.

Some stations cannot properly receive frames with a Source Routing RIF on them. This is especially common among NetWare drivers. Disabling source routing in this situation will allow you to communicate with these stations.

Source routing should be enabled only if there are source-routing bridges on this ring that you want to bridge IP, IPX, and AppleTalk Phase 2 packets through. Source routing must also be enabled so LLC test response messages can be returned.

#### Syntax:

```
source-routing          enable
                        disable
```

### Speed

Use the **speed** command to change data speed. The default speed is 4 Mbps. Enter the **speed** command followed by the speed-value (in Mbps).

#### Syntax:

```
speed                  speed-value
```

#### speed-value

The speed to which you are setting the token-ring interface.

**Valid values:** 4 or 16 Mbps

**Default value:** 4 Mbps

---

## Accessing the Interface Monitoring Process

To display the Token-Ring monitoring prompt (TKR>), enter the network command followed by the interface number of the Token-Ring interface. For example:

```
+network 0
TKR>
```

Use the **list devices** command at the Config> prompt to display a list of interface numbers configured on the router.

Follow the procedure described in “Accessing the Network Interface Configuration Process” on page 15 to access the interface monitoring process for the interface described in this chapter. Once you have accessed the desired interface monitoring process, you can begin entering monitoring commands.

## Token-Ring Interface Monitoring Commands

This section summarizes the Token-Ring monitoring commands. Enter commands at the TKR> monitoring prompt. Table 26 lists the monitoring commands.

Table 26. Token-Ring Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Dump	Displays a dump of the RIF cache.
LLC	Displays the LLC monitoring prompt.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### Dump

When source routing is enabled in the `tkr config>` process, you can use the **dump** command to request a dump of the RIF cache contents.

#### Syntax:

**dump**

#### Example:

```
dump
MAC address      State      Usage      RIF
0000C90B1A57    ON_RING   Yes        0220
```

#### MAC address

Displays the MAC address of the Token-Ring interface.

**State** Displays one of the interface states:

On\_ring - indicates that a RIF was found for a node on the ring.

Have\_route - indicates that a RIF was found for a node on a remote ring.

No\_route - is displayed for a brief period of time as an explorer frame is sent out and the router is waiting for a return.

Discovering - indicates that the router sent an explorer frame to rediscover the RIF.

St\_route - indicates that a route obtained from a Spanning tree explorer.

**Usage** Indicates that a RIF was used in a packet. The number is arbitrary and has no functional significance.

**RIF** Displays a code that indicates the RIF in hexadecimal.

**Note:** The RIF is displayed only if Source Route Bridging is enabled on the Token-Ring interface.

- NetBIOS RIF data can be displayed using the following sequence of commands: **talk 5, protocol ASRT, name-caching, list cache rifs.**
- Data Link Switching RIF data can be displayed using the following sequence of commands: **talk 5, protocol dlsw, list llc2 session all.**

## Configuring Token-Ring Network Interfaces

### LLC

Use the **LLC** command to access the LLC monitoring prompt. LLC commands are entered at this new prompt. See “LLC Monitoring Commands” on page 236 for an explanation of each of these commands.

#### Syntax:

llc

---

## Token-Ring Interfaces and the GWCON Interface Command

While Token-Ring interfaces have their own monitoring processes for monitoring purposes, the router also displays complete statistics for installed network interfaces when you use the **interface** command from the GWCON environment.

### Statistics Displayed for 802.5 Token-Ring Interfaces

The following statistics display when you enter the **interface <net#>** command for a Token-Ring interface from the GWCON environment.

Nt	Nt'	Interface	Slot-Port	Self-Test Passed	Self-Test Failed	Maintenance Failed
0	0	TKR/0	Slot: 1 Port: 1	1	0	0

Token-Ring/802.5 MAC/data-link on Token-Ring interface

Physical address	08005AFE0106		
Microcode Level	ww19cg		
Network speed	16 Mbps		
Max packet size (INFO)	2052		
Handler state	Ring open		
Last Reported Ring status	SERR   CO		
# times Signal lost	0	# times Beaconing	0
Hard errors	0	Loose wire faults	0
Auto-removal errors	0	Removes received	0
Ring recovery actions	0		
Line errors	0	Burst errors	0
ARI/FCI errors	0	Inputs dropped	0
Frame copy errors	0	Token errors	0
Lost frames	0		
Input overflows	0	Driver output errors	0

The following section describes general interface statistics:

**Nt** Global interface number

**Nt'** Applies only to dial circuits

#### Interface

Interface name and Number of this interface within interfaces of type “intrfc”

**Port** Port number

**Slot** Slot number

#### Self-Test: Pass

Number of times self-test succeeded

#### Self-Test: Fail

Number of times self-test failed

#### Maint: Fail

Number of maintenance failures



## Using the GWCON Interface Command

The following section describes the statistics displayed that are specific to the Token-Ring interfaces:

### Physical address

Specifies the physical address of the Token-Ring interface.

### Network speed

Specifies the speed of the Token-Ring network that connects to the interface. The Network Speed counter displays the number of packets that the interface can pass per second.

### Max packet size (info)

Displays the maximum packet size configured for that interface. The Max Packet Size counter displays the maximum length, in bytes, of a packet that the interface transmits or receives. This counter is user-defined.

### Handler state

Displays the current state of the Token-Ring handler. The Handler state counter displays the state of the handler after the self-test runs.

### Last ReportedRing status

Last Ring Status of the Token Ring interface.

- SIGL** SIGNAL\_LOSS The interface has detected a loss of signal on the ring.
- HERR** HARD\_ERROR The interface is presently transmitting or receiving beacon frames on the ring.
- SERR** SOFT\_ERROR The interface has transmitted a report error MAC frame.
- BEAC** TRANSMIT\_BEACON The interface is transmitting beacon frames to or from the ring.
- LWF** LOBE\_WIRE\_FAULT The interface has detected an open or short circuit in the cable between the interface and the wiring concentrator. The interface is closed and is at the state following initialization.
- ARMV** AUTO\_REMOVAL\_ERROR The interface has failed the lobe wrap test, which resulted from the beacon auto-removal process, and has removed itself from the ring. The interface has closed and is at the state following initialization.
- RMVD** REMOVED\_RECEIVED The interface has received a remove ring station MAC frame request and has removed itself from the ring. The interface is closed and is at the state following initialization.
- CO** COUNTER\_OVERFLOW One of the following error counters has incremented from 254 to 255: Line, ARI/FCI, Frame Copy, Lost Frames, Burst, Lobe wire faults, Removes received. This display shows these error counters.
- SSTA** SINGLE\_STATION The interface has sensed that it is the only station on the ring.
- RR** RING\_RECOVERY The interface observes claim Token MAC frames on the ring. The interface may be transmitting the claim Token frames. This status remains until the interface transmits a ring purge frame.

## Using the GWCON Interface Command

### **# of times signal lost**

Specifies the total number of times that the router was unable to transmit a packet due to loss of signal.

### **Hard errors**

Displays the number of times the interface transmits or receives beacon frames from the network.

### **Auto-removal errors**

Displays the number of times the interface, due to the beacon auto-removal process, fails the lobe wrap test and removes itself from the network.

### **Ring recovery actions**

Displays the number of times the interface detects claim token medium access control (MAC) frames on the network.

### **Line errors**

The Line Errors counter increments when a frame is repeated or copied and the Error Detected Indicator (EDI) is zero for the incoming frame:

One of the following conditions must also exist:

- A token with a code violation exists.
- A frame has a code violation between the starting and ending delimiter.
- A Frame Check Sequence (FCS) error occurs.

### **ARI/FCI errors**

The ARI/FCI (Address Recognized Indicator/Frame Copied Indicator) Errors counter increments if the interface receives either of the following:

An Active Monitor Present (AMP) MAC frame with the ARI/FCI bits equal to zero and a Standby Monitor Present (SMP) MAC frame with the ARI/FCI bits equal to zero.

More than one SMP MAC frame with the ARI/FCI bits equal to zero, without an intervening AMP MAC frame.

This error indicates that the upstream neighbor copied the frame but is unable to set the ARI/FCI bits.

### **Frame copy errors**

Displays the number of times the interface in receive/repeat mode recognizes a frame addressed to its specific address but finds the address recognize indicator (ARI) bits not equal to zero. This error indicates a possible line hit or duplicate address.

### **Lost frames**

Displays the number of times the interface is in transmit mode (stripping) and fails to receive the end of a transmitted frame.

### **Input overflows**

Specifies the number of frames that were received that were larger than the input buffer size. Frames that are too large to fit into a single input buffer are discarded.

### **# times beaconing**

Displays the number of times the interface transmits a beacon frame to the network.

### **Lobe wire faults**

Displays the number of times the network detects an open or short circuit in the cable between the interface and the wiring concentrator.

### Removes received

Displays the number of times the interface receives a remove ring station MAC frame request and removes itself from the network.

### Burst errors

Displays the number of times the interface detects the absence of transitions for five half-bit times between the start delimiter (SDEL) and the end delimiter (EDEL) or between the EDEL and the SDEL.

### Inputs dropped

Displays the number of times an interface in repeat mode recognizes a frame addressed to it but has no buffer space available to copy the frame.

### Token errors

The token errors counter increments when the active monitor detects a token protocol with any of the following errors:

- The MONITOR\_COUNT bit of token with nonzero priority equals one.

- The MONITOR\_COUNT bit of a frame equals one. No token or frame is received within a 10-ms window.

- The starting delimiter/token sequence has a code violation in an area where code violations must not exist.

---

## Token-Ring Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

Token Ring supports the CONFIG (Talk 6) **delete interface** command with the following consideration:

- When the interface is removed, the source routing record is deleted, and higher number records are renumbered.

### GWCON (Talk 5) Activate Interface

Token Ring supports the GWCON (Talk 5) **activate interface** command with no restrictions.

All Token Ring interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

### GWCON (Talk 5) Reset Interface

Token Ring supports the GWCON (Talk 5) **reset interface** command with the following consideration:

- If the maximum packet size has been set higher than the size for user data, the 2216 must be rebooted.

All Token Ring interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.



---

## Chapter 15. Configuring and Monitoring the Fast Token-Ring Network

Fast Token-Ring FasTR uses the existing IBM 2216 ATM adapters as fast token-ring adapters. It supports IP routing, DLSw, APPN, and SRB (Source Route Bridging).

This chapter describes FasTR network configuration and operational commands for FasTR. It includes the following sections:

- “Accessing the FasTR Interface Configuration Process”
- “FasTR Configuration Commands”
- “Accessing the Interface Monitoring Process” on page 218
- “FasTR Interface Monitoring Commands” on page 218
- “FasTR Interfaces and the GWCON Interface Command” on page 219

---

### Accessing the FasTR Interface Configuration Process

To display the FasTR `config>` prompt, enter the network command followed by the interface number of the FasTR interface. For example:

```
Config>network 0
Fast Token-Ring interface configuration
FasTR Config>
```

Use the **list devices** command at the `Config>` prompt to display a list of interface numbers configured on the router.

**Note:** Whenever you change a parameter, you must restart the router for the changes to take effect.

---

### FasTR Configuration Commands

This section describes the FasTR configuration commands. Enter the commands at the FasTR `config>` prompt. Table 27 lists FasTR configuration commands.

Table 27. FasTR Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Displays the selected FasTR interface configuration.
LLC	Accesses the LLC configuration environment and subcommands.
Media	Defaults to fiber. No input allowed.
Packet-size	Sets maximum packet-size for FasTR networks.
Set	Sets the aging timer for the RIF cache and the physical (MAC) address.
Source-routing	Enables or disables source-routing on the interface.
Speed	Defaults to 155 Mbps. No input allowed.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

#### List

Use the **list** command to display the current configuration for the FasTR interface.

**Note:** If the MAC address is 0, the default station address is used.

## Configuring the FasTR Network

### Syntax:

list

### Example:

**list**

```
Fast Token-Ring configuration:

    Packet size (INFO field): 2052
Speed:                        155Mbps
Media:                        Fiber

RIF Aging Timer:             120
Source Routing:              Enabled
MAC Address:                  000000000000
```

Packet size	Maximum FasTR packet size.
Speed	Speed of the network, 155Mbps.
Media	Type of media the network uses, fiber.
RIF Aging Timer	Amount of time that the router holds the information contained in the Routing Information Field (RIF).
Source Routing	Status of the source-routing feature, enabled or disabled.
MAC Address	Configured MAC address that was set with the <b>set physical-address</b> command. If all zeros are displayed, the MAC address is the default address.

## LLC

Use the **LLC** command to access the LLC configuration environment. See “LLC Configuration Commands” on page 233 for an explanation of each of these commands.

### Syntax:

llc

### Example:

**llc**

```
LLC config>
```

**Note:** If APPN is not included in your router software load, you will receive the following message if you try to use this command:

```
LLC configuration is not available for this network.
```

The LLC configuration environment is only available if APPN is included in the software load.

## Media

The default media type is fiber. No input allowed.

## Packet-Size

Use the **packet-size** command to set the maximum packet-size for FasTR networks. Enter the **packet-size** command followed by the desired number of bytes.

**Note:** If the packet size is increased, buffer memory requirements will also increase.

### Syntax:

packet-size #bytes

### Example:

**packet-size 4399**

## Set

Use the **set** command to set the Routing Information Field (RIF) timer and the physical (MAC) address.

**Syntax:** **set**  
     physical-address  
     rif-timer

### physical-address

Indicates whether you want to define a locally administered address for the FasTR interface's MAC sublayer address, or use the default factory station address (indicated by all zeroes). The MAC sublayer address is the address that the FasTR interface uses to receive and transmit frames.

**Note:** Pressing **Return** leaves the value the same. Entering **0** and pressing **Return** causes the router to use the factory station address. The default is to use the factory station address.

**Valid values:** Any 12-digit hexadecimal address.

**Default value:** burned-in address (indicated by all zeroes).

### Example:

```
set physical-address
MAC address in 00:00:00:00:00:00 form []?
```

### rif-timer

Sets the maximum amount of time (in seconds) that the information in the RIF is maintained before it is refreshed. The default is 120.

### Example:

```
set rif-timer
RIF aging timer value [120]? 120
```

## Source-routing

Use the **source-routing** command to enable or disable end station source routing. Source routing is the process by which end stations determine the source route to use to cross source routing bridges. Source routing allows the IP protocol to reach nodes on the other side of the source routing bridge.

This switch is completely independent of whether this interface is providing source routing via the SRT forwarder. The default setting is enabled.

Some stations cannot properly receive frames with a Source Routing RIF on them. This is especially common among NetWare drivers. Disabling source routing in this situation will allow you to communicate with these stations.

Source routing should be enabled only if there are source-routing bridges on this ring that you want to bridge IP packets through. Source routing must also be enabled so LLC test response messages can be returned.

**Syntax:** **source-routing**  
     enable  
     disable

**Example:** **source-routing enable**

## Configuring the FasTR Network

### Speed

The default speed is 155 Mbps. No input allowed.

---

## Accessing the Interface Monitoring Process

To display the token-ring monitoring prompt (TKR>), enter the network command followed by the interface number of the FasTR interface. For example:

```
+network 0
TKR>
```

Use the **list devices** command at the Config> prompt to display a list of interface numbers configured on the router.

Follow the procedure described in “Chapter 13. Getting Started with Network Interfaces” on page 203 to access the interface monitoring process for the interface described in this chapter. Once you have accessed the desired interface monitoring process, you can begin entering monitoring commands.

---

## FasTR Interface Monitoring Commands

This section describes the FasTR monitoring commands. Enter commands at the TKR> monitoring prompt. Table 28 lists the monitoring commands.

Table 28. FasTR Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Dump	Displays a dump of the RIF cache.
LLC	Displays the LLC monitoring prompt.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Dump

When source routing is enabled in the FasTR config> process, you can use the **dump** command to request a dump of the RIF cache contents.

#### Syntax:

```
_dump
```

#### Example:

```
dump
```

```
MAC address  State  Usage  RIF
0000C90B1A57  ON_RING  Yes    0220
```

MAC address

Displays the MAC address of the FasTR interface.

State

Displays one of the interface states:

On\_ring - indicates that a RIF was found for a node on the ring.

Have\_route - indicates that a RIF was found for a node on a remote ring.

No\_route - is displayed for a brief period of time as an explorer frame is sent out and the router is waiting for a return.

Discovering - indicates that the router sent an explorer frame to rediscover the RIF.

St\_route - indicates that a route obtained from a Spanning tree explorer.



## Configuring the FasTR Network

Usage	Indicates that a RIF was used in a packet. The number is arbitrary and has no functional significance.
RIF	Displays a code that indicates the RIF in hexadecimal. <b>Note:</b> The RIF is displayed only if Source Route Bridging is enabled on the FasTR interface. <ul style="list-style-type: none"><li>• NetBIOS RIF data can be displayed using the following sequence of commands: <b>talk 5, protocol ASRT, name-caching, list cache rifs.</b></li><li>• Data Link Switching RIF data can be displayed using the following sequence of commands: <b>talk 5, protocol dlsw, list llc2 session all.</b></li></ul>

## LLC

Use the **LLC** command to access the LLC monitoring prompt. LLC commands are entered at this new prompt. See “LLC Monitoring Commands” on page 236 for an explanation of each of these commands.

### Syntax:

llc

### Example:

llc

```
LLC user monitoring
LLC>
```

---

## FasTR Interfaces and the GWCON Interface Command

While FasTR interfaces have their own monitoring processes for monitoring purposes, the router also displays complete statistics for installed network interfaces when you use the **interface** command from the GWCON environment.

## Statistics Displayed for FasTR Interfaces

The following statistics display when you enter the **interface <net #>** command for a FasTR interface from the GWCON environment.

```
+i 0
Nt Nt' Interface Slot-Port Self-Test Self-Test Maintenance Failed
0 0 TKR/0 Slot: 1 Port: Passed 1 Failed 1 Failed 0
0

Token-Ring/802.5 MAC/data-link on Fast Token Ring interface

Physical address 000000019100
Network speed 155 Mbps
Max packet size (INFO) 2052
Handler state Ring open

Hdr Thresh: 0 Bad CRC: 0
Bad Length: 0 Max Len Exc.: 0
Rcv Timeout: 0 Fwd Aborts: 0
Nonzero CPI: 0

Cells Rcvd: 0 NUD Rcvd: 0
NUD Bad CRC: 0 Bad HEC: 0

LCD Events:
AAL0 No Buf: 0 AAL5 No Buf: 0
NUD No Buf: 0
Rx No Sysbuf: 0 Tx No Chrmbf: 0

GPDMA Events:
Tx DMA Error: 0 Rx DMA Error: 0
Buf Overflow: 0 Virt Mem Res: 0
Lost Events: 0 Ill. Events: 0
+
```

## Using the GWCON Interface Command

The following section describes general interface statistics:

Nt	Global interface number
Nt'	Applies only to dial circuits
Interface	Interface name and Number of this interface within interfaces of type <i>intrfc</i>
Slot-Port	Slot number and Port number
Self-Test: Pass	Number of times self-test succeeded
Self-Test: Fail	Number of times self-test failed
Maintenance Failed	Number of maintenance failures

The following section describes the statistics displayed that are specific to the FasTR interfaces:

Physical address	Specifies the physical address of the FasTR interface.
Network speed	Specifies the speed of the FasTR network that connects to the interface. The Network Speed counter displays the number of packets that the interface can pass per second.
Max packet size (info)	Displays the maximum packet size configured for that interface. The Max Packet Size counter displays the maximum length, in bytes, of a packet that the interface transmits or receives. This counter is user-defined.
Handler state	Displays the current state of the FasTR handler. The Handler state counter displays the state of the handler after the self-test runs.
Hdr Thresh	Packet header thresholds exceeded.
Bad CRC	Packets received with bad CRC.
Bad Length	Packets received with bad length.
Max Len Exc.	Packets received exceeding maximum length.
Rcv Timeout	Timeouts on received packet reassembly.
Fwd Aborts	Received packets terminated with a forward abort.
Nonzero CPI	Packets received with CPI field not set to zero.
Cells Received	Cells received (not packets).
NUD Rcvd	Non-user data fields received.
NUD Bad CRC	Non-user data fields received with bad CRC_10.
Bad HEC	Cells received with bad Header Error Check.
LCD Events	
AAL0 No Buf	AAL0 cells dropped due to lack of pools buffers.
AAL5 No Buf	AAL5 cells dropped due to lack of pools buffers.
NUD No Buf	Non-user data dropped due to lack of pools buffers.
Rx No Sysbuf	Packets received but dropped because no system buffers were available.
Tx No Chrmbuf	Transmit packets dropped because no adapter buffers were available.
GPDMA Events	
Tx DMA Error	Transmit DMAs with errors.
Rx DMA Error	Receive DMAs with errors.
Buf Overflow	Received packets that exceeded the real buffer size.
Virt Mem Res	Virtual Memory resource events, writing cells into virtual memory.
Lost Events	Events lost because the receive queue was full.
Ill. Events	Unrecognized events.

---

## Chapter 16. Using FDDI

This chapter describes how to set software-configurable information for the Fiber Distributed Data Interface (FDDI) in the router.

This chapter contains the following sections:

- “Fiber Distributed Data Interface (FDDI) Overview”

---

### Fiber Distributed Data Interface (FDDI) Overview

Fiber Distributed Data Interface (FDDI) is described by the ANSI X3T9.5 and ISO 9314 committees as a dual counter-rotating ring that operates at a defined speed of 100 Mbps.

In many ways, FDDI is similar to the IEEE 802.5 token-ring, although there are differences, some of which are described in “Differences Between FDDI and Token-Ring” on page 222.

### Token-Passing Ring Network

FDDI is defined as a token-passing protocol. Each station has the chance to transmit data when a token passes. A station can decide how many frames it will transmit using an algorithm that permits “bandwidth” allocating.

FDDI also allows a station to transmit many frames without releasing the token in a way that is similar to the IEEE 802.5 token-ring standard.

An FDDI ring network consists of a set of stations/devices connected as a serial string of stations/devices and transmission media to form a physically closed loop. Information is transmitted sequentially as a stream of suitably encoded signals from one active station/device to the next active one.

Each station/device generally regenerates and repeats each token and can serve as the means of attaching one or more stations/devices to the network.

### Primary and Secondary Rings

FDDI defines two rings:

- The *primary ring*, which is similar to the main ring path in a token-ring network.
- The *secondary ring*, which is similar to the backup ring path in a token-ring network.

Each ring path consists of two fibers, each fiber transmitting one signal; one is pushed and one is pulled in a device. Each fiber is equivalent to a pair of copper conductors. The physical approach in terms of fiber optics is similar to physical fiber optic token-ring paths.

### Attachment of Devices

FDDI permits many attachment units:

- Stations or devices
- Concentrators
- Bridges

These units can be attached to FDDI networks in various ways, similar to those for token-ring networks.

## Using FDDI

### Differences Between FDDI and Token-Ring

The main differences between FDDI and token-ring techniques are:

- A device can be attached directly to rings without a concentrator, such as a multi-station access unit (MSAU) on a token ring.
- A device can be attached to either or both of the primary and secondary rings.

FDDI defines two device classes, A and B, to differentiate between devices that attach to one ring or both rings, as described in the next section.

### Device Classes A and B

FDDI defines two device classes:

- A **Class A** device attaches to both rings directly.  
It can be a station, called a *Class A station* or *Dual Access Station (DAS)*, or it can be a Concentrator, called a *Dual Access Concentrator (DAC)*
- A **Class B** device attaches to only one of the rings directly or through a concentrator.  
It can be a station, called a *Class B station* or *Single Access Station (SAS)*, or it can be a Concentrator, called a *Single Access Concentrator (SAC)*

## FDDI Network Diagram

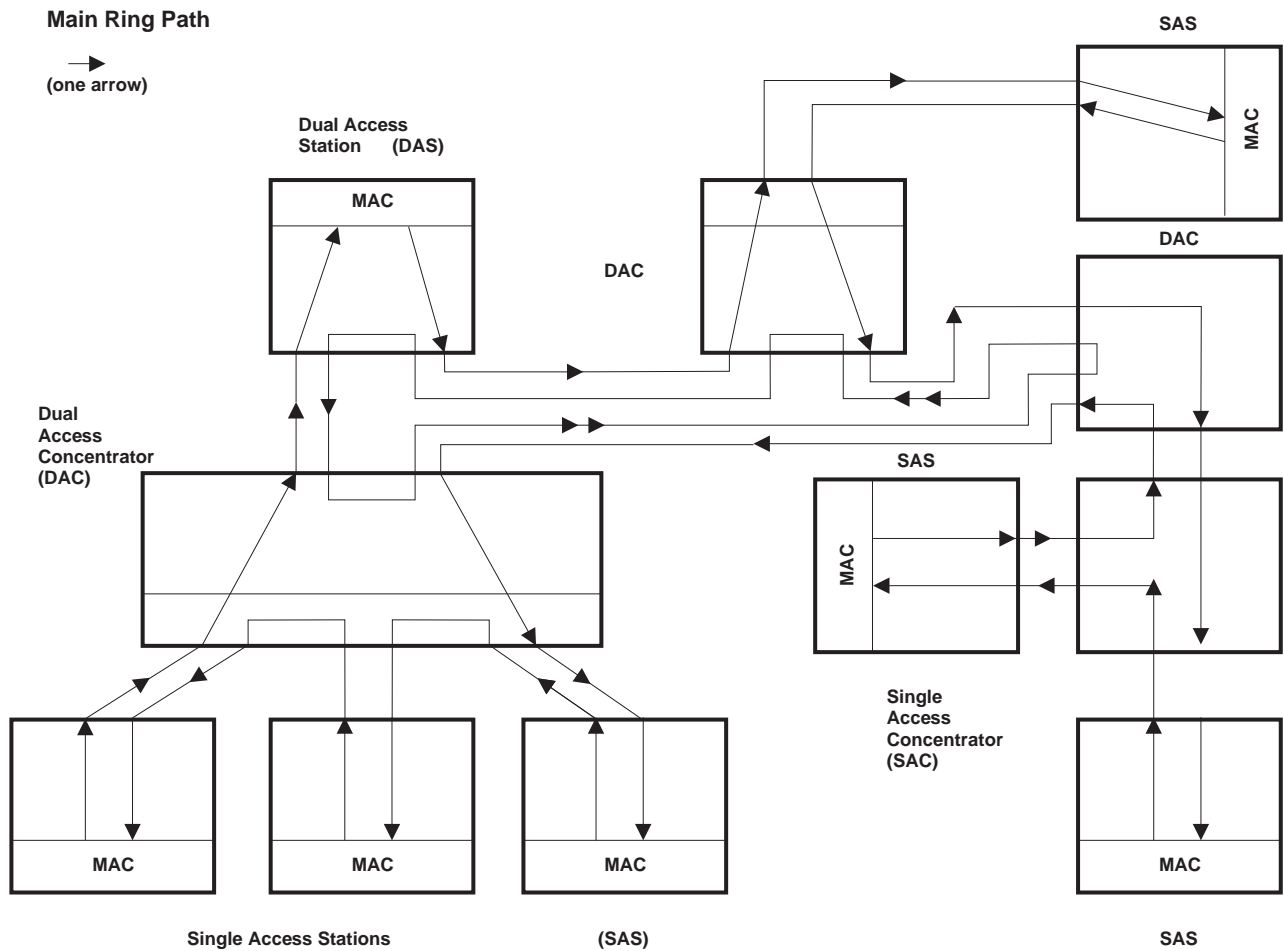


Figure 14. FDDI Network Diagram. This diagram shows Single Access Stations (SAS), Dual Access Stations (DAS), Single Access Concentrators (SAC), and Dual Access Concentrators (DAC) in one Main Ring Path of an FDDI network.

## Using FDDI

---

## Chapter 17. Configuring and Monitoring FDDI

This chapter describes the FDDI interface configuration and operational commands. It includes the following sections:

- “Accessing the FDDI Configuration Commands”
- “FDDI Configuration Commands”
- “Accessing FDDI Monitoring Commands” on page 227
- “FDDI Monitoring Commands” on page 228

---

### Accessing the FDDI Configuration Commands

You can access FDDI configuration from Talk 6. To do so, enter the **add device** command to add an FDDI interface to the network and assign an interface number to it, and then use the **network** command to access the FDDI interface as shown in the following example:

```
Config> add device fddi
SK-NET FDDI device in slot 0 port 1 as interface #2
Use "net 2" to configure SK-NET FDDI parameters

Config> network ?
0 :CHARM ATM Adapter
1 :ATM Token Ring LAN Emulation: elan1
2 :SK-NET FDDI

Config> network 2
FDDI Interface Configuration
FDDI Config>
```

This will get you to the FDDI Config> prompt.

When you are finished, enter **Exit** to return to the previous prompt level.

---

### FDDI Configuration Commands

This section describes the FDDI configuration commands as shown in Table 29. Enter the commands from the FDDI Config> prompt.

*Table 29. FDDI Configuration Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Displays the selected FDDI configuration.
LLC	Provides access to the LLC configuration environment.
Set	Sets FDDI parameters.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### List

Use the **list** command to display the current configuration for the FDDI.

#### Syntax:

```
list                all
all                Lists all of the output for the various parameters that follow.
```

```
FDDI Config [4]>LIST ALL
FDDI configuration:

Locally Admin. Address:  40:00:00:12:34:56
```

## Configuring FDDI

```
T_Max (in ms): 165 (default)
T_Min (in ms): 5 (default)
Requested Target Rotation Time (in ms): 165 (default)
Valid transmission expiration timer (in us): 2500 (default)
Link Error Rate Alarm Port A: 100-8 (default)
Link Error Rate Cutoff Port A: 100-7 (default)
Link Error Rate Alarm Port B: 100-8 (default)
Link Error Rate Cutoff Port B: 100-7 (default)
PMF password:
User data:
```

## LLC

Use the **LLC** command to access the LLC configuration environment. See “LLC Configuration Commands” on page 233 for an explanation of LLC command.

### Syntax:

llc

## Set

Use the **set** command to configure FDDI.

### Syntax:

```
set                ler
                    physical-address
                    pmf
                    tmax
                    tmin
                    treq
                    tvx
                    userdata
```

**ler port# type** Sets the alarm and cutoff values for port A and port B as follows:

#### **ler a alarm**

Sets the alarm values for port A.

#### **ler a cutoff**

Sets the cutoff values for port A.

#### **ler b alarm**

Sets the alarm values for port B.

#### **ler b cutoff**

Sets the cutoff values for port B.

### Valid values and defaults

Alarm or Cutoff	Valid Values	Default
Alarm	4 to 15	8
Cutoff	4 to 15	7

### physical-address

Indicates whether you want to define a locally administered address for FDDI interface’s MAC sublayer address, or use the default factory station address (indicated by all zeroes). The MAC sublayer address is the address that the FDDI interface uses to receive and transmit frames.



**Note:** Pressing **Return** leaves the value the same. Entering **0** and pressing **Return** causes the router to use the factory station address. The default is to use the factory station address.

**Valid values:** Any 12-digit hexadecimal address.

**Default value:** burned-in address (indicated by all zeroes).

**Example:**

```
set physical-address
MAC address in 00:00:00:00:00:00 form []?40:00:00:12:34:56
```

<b>pmf</b>	Sets the PMF Password (maximum of 8 characters).
<b>tmax</b>	Sets the Maximum Token Rotation Time (in milliseconds) that this station can accept. Commonly referred to in FDDI specifications as T_Max.  <b>Valid values:</b> 5 to 165 milliseconds <b>Default:</b> 165 milliseconds
<b>tmin</b>	Sets the Minimum Token Rotation Time (in milliseconds) that this station can accept. If the negotiated TTRT is less than this value, then the adapter will not provide proper service to the layers above it. Commonly referred to in FDDI specifications as T_Min.  <b>Valid values:</b> 5 to 165 milliseconds <b>Default:</b> 5 milliseconds
<b>treq</b>	Sets the Requested Target Token Rotation Time (in milliseconds) that this station will bid during initialization. Commonly referred to in FDDI specifications as T_Req.  <b>Valid values:</b> 5 to 165 milliseconds <b>Default:</b> 165 milliseconds
<b>tvx</b>	Sets the Valid transmission timer expiration (in microseconds). This timer is reset every time a valid frame or nonrestricted token is seen by the station. If the timer expires, it indicates that traffic is not circulating properly on the ring and therefore the claim process is started. Commonly referred to in FDDI specifications as TVX.  <b>Valid values:</b> 2500 to 10 000 microseconds <b>Default:</b> 2500 microseconds.
<b>userdata</b>	Sets the User data (maximum of 32 characters).

---

## Accessing FDDI Monitoring Commands

You can access FDDI configuration from Talk 5 by entering the **network** command to access the FDDI interface as shown in the following example:

```
network ?
0 :CHARM ATM Adapter
1 :ATM Token Ring LAN Emulation: elan1
2 :SK-NET FDDI

network 2
FDDI Interface
FDDI>
```

This will get you to the FDDI> prompt.

## Monitoring FDDI

When you are finished, enter **Exit** to return to the previous prompt level.

---

## FDDI Monitoring Commands

The monitoring commands for FDDI are:

*Table 30. FDDI Monitoring Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
List	Displays the FDDI adapter information
LLC	Displays the LLC monitoring prompt.
Srt-stat	Displays the FDDI bridging statistics.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### List

Use the **list** command to display the current FDDI configuration parameters.

**Syntax:**

**list**

**Example:**

```
FDDI> list
MAC Address: 40:00:00:12:34:56
Bridging Disabled
```

### LLC

Use the **LLC** command to access the LLC configuration environment. See "LLC Configuration Commands" on page 233 for an explanation of LLC command.

**Syntax:**

**llc**

### Srt-stat

Use the **srt-stat** command to display the hardware assisted bridged statistics on this interface.

**Syntax:**

**srt-stat**

**Example:**

```
srt-stat
Port Supports:          Transparent Bridging Only

Frames received:          806
Bytes received:          34588
Maximum size of filter table in adapter: 4088
Number of entries in filter table: 0
Number of dynamic entries in filter table: 0
```

## FDDI Interfaces and the GWCON Command

While the FDDI interfaces have their own monitoring processes for monitoring, the router also displays complete statistics for installed network interfaces when you use the interface command from the GWCON environment.

## Statistics Displayed from FDDI Interfaces

The following statistics are displayed when you enter the **interface net#** command for a FDDI interface from the GWCON environment.

```

Nt Nt' Interface Slot-Port Self-Test Self-Test Maintenance
0 0 FDDI/0 Slot: 1 Port: 1 Passed Failed Failed
                                1 0 0

IEEE 802.2/FDDI MAC/data-link on SK-NET FDDI interface
Address: 00:60:94:C4:00:40
UNA: 00:00:5A:02:2D:1E -> DNA: 00:00:5A:02:2D:1E
-----
ECM State Machine: IN
PCM State Machine Port A: SIGNAL
PCM State Machine Port B: ACTIVE
CFM State Machine Port A: ISOLATED
CFM State Machine Port B: CONCATENATED
CF State Machine: C_WRAP_B
MAC Current Path: PRIMARY
RMT State Machine: RING_OP
-----
TVX expired ct: 0
Beacon ct: 0
Claim ct: 0
RingOp ct: 1
-----
PHYA:LEM_Ct: 0 LEM_Reject Ct: 0 LCT fails: 40
Alarm: 10^-8 CuToff: 10^-7 Estimate: 10^-15
PHYB:LEM_Ct: 0 LEM_Reject Ct: 0 LCT fails: 40
Alarm: 10^-8 CuToff: 10^-7 Estimate: 10^-15
-----
T_Notify 10 sec, SMT frames in:55363 SMT frames out:35317
-----
Frames:211764, Errors:0, Losts:0, Xmts:144058, Copied:171046, Not Copied:0

```

The following section describes general interface statistics:

**Nt** Global interface number

**Nt'** Applies only to dial circuits

### interface

Interface name and number of this interface within interfaces of type *intrfc*.

**Port** Port number

**Slot** Slot number

### Self-Test Passed

Number of times self-test succeeded.

### Self-Test Failed

Number of times self-test failed.

### Maintenance Failed

Number of maintenance failures.

The following section describes the statistics displayed that are specific to the FDDI interfaces:

### Address

Specifies the physical address of the FDDI interface.

**UNA** Specifies the physical address of the upstream neighbor.

**DNA** Specifies the physical address of the downstream neighbor.

### ECM State Machine

Entity Coordination Management controls the management of the media interface, including all the ports at the node. It also controls the optical bypass.

## Monitoring FDDI

OUT  
IN  
TRACE  
LEAVE  
PATH-TEST  
INSERT  
CHECK  
DEINSERT

### PCM State Machine

Physical Connection Management controls the management of the physical connection between a port being managed and another port in the adjacent node.

OFF  
BREAK  
TRACE  
CONNECT  
NEXT  
SIGNAL  
JOIN  
VERIFY  
ACTIVE  
MAINT

### CFM State Machine

Configuration Management manages the configuration of MACs and ports within a node.

ISOLATED  
LOCAL  
SECONDARY  
PRIMARY  
CONCATENATED  
THRU

### CF State Machine

Attachment configuration.

ISOLATED  
LOCAL\_A  
LOCAL\_B  
LOCAL\_AB  
LOCAL\_S  
WRAP\_A  
WRAP\_B  
WRAP\_AB  
WRAP\_S  
C\_WRAP\_A  
C\_WRAP\_B  
C\_WRAP\_S  
THRU

### MAC Current Path

Current path which this MAC is inserted.

ISOLATED  
LOCAL  
SECONDARY  
PRIMARY

### RMT State Machine.

Ring Management controls the timing of the MAC management frames.

ISOLATED  
NON\_OP  
RING\_OP  
DETECT\_BEACON  
NON\_OP\_DUP  
RING\_OP\_DUP  
DIRECTED  
RM-TRACE  
DETECT\_CLAIM  
DETECT\_IDLE

### TVX expired ct

Number of times TVX expired.

### Beacon ct

Number of times beacon state entered.

**Claim ct**

Number of times claim state entered.

**RingOp ct**

Number of times ring has entered operational state.

**LEM\_Ct**

Link error monitor error count.

**LCT fails**

Count of consecutive times the link confidence test has failed.

**Alarm** Estimate at which a link connection will generate an alarm.

**Cutoff** Estimate at which a link connection will be broken.

**Estimate**

Long term average link error rate.

**Frames**

Number of frames received.

**Errors** Number of frames detected in error.

**Losts** Number of format errors during reception.

**Xmts** Number of frames transmitted.

**Copied**

Number of frames copied.

**Not Copied**

Number of frames not copied.

**T\_Notify**

Neighbor notification timer.

**SMT frames in**

Number of SMT frames received.

**SMT frames out.**

Number of SMT frames sent.

## Monitoring FDDI

---

## Chapter 18. Configuring and Monitoring LLC Interfaces

This chapter describes how to configure specific LLC interfaces in the router by using either the interface commands or the GWCON interface command.

Logical Link Level can be thought of as a “sub-protocol”. It is not accessed directly from either the Talk 6 (configuration) or the Talk 5 (monitoring) environment. Instead, it is accessed from the Token Ring, Point-to-Point (PPP), or Frame Relay protocols by entering an **LLC** command.

This chapter includes the following sections:

- “Accessing the Interface Configuration Process”
- “Accessing the Interface Monitoring Process” on page 236
- “LLC Monitoring Commands” on page 236
- “LLC Configuration Commands”

---

### Accessing the Interface Configuration Process

Access the configuration commands for the protocol you wish to configure over LLC:

- Token Ring, as described in “Chapter 14. Configuring IEEE 802.5 Token-Ring Network Interfaces” on page 205
- Point-to-Point, as described in “Chapter 43. Using Point-to-Point Protocol Interfaces” on page 581
- Frame Relay, as described in “Chapter 41. Using Frame Relay Interfaces” on page 497
- FDDI, as described in “Chapter 16. Using FDDI” on page 221

Each of these prompt levels has an LLC command. Enter **LLC** to access the LLC configuration commands and perform LLC configuration. When you are finished, enter **Exit** to return to the prompt level for the protocol you are configuring.

---

### LLC Configuration Commands

LLC configuration is required when you need to pass packets over an SNA network. To enter these commands, you must first enter the LLC configuration environment (see “Accessing the Token-Ring Interface Configuration Process” on page 205).

This section summarizes and then explains all of the LLC configuration commands. These commands, shown in Table 31, enable you to configure LLC when you need to pass packets over a SNA network.

*Table 31. LLC Configuration Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Displays the selected LLC configuration.
Set	Sets the timers associated with LLC, and the size of the transmit and receive windows.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## Configuring LLC

### List

Use the **list** command to display the current configuration for the LLC.

#### Syntax:

**list**

#### Example:

```
list
Reply Timer (T1):           1 seconds
Receive ACK Timer (T2):    100 milliseconds
Inactivity Timer (Ti):      30 seconds
Max Retry value (N2):      8
Rcvd I-frames before ACK (N3): 1
Transmit Window (Tw):      2
Receive Window (Rw):       2
Acks needed to increment Ww (Nw): 1
```

#### Reply Timer (T1)

This timer expires when the LLC fails to receive a required acknowledgment or response from the other LLC station.

#### Receive ACK Timer (T2)

This timer is used to delay sending of an acknowledgment for a received I-format frame.

#### Inactivity Timer (Ti)

This timer expires when the LLC does not receive a frame for a specified time period. When this timer expires the LLC transmits an RR until the other LLC responds or the N2 retry count is exceeded. Default is 30 seconds.

#### Max Retry value (N2)

The maximum number of retries by the LLC protocol. Default is 8.

#### Rcvd I-frames before ACK (N3)

This value is used with the T2 timer to reduce acknowledgment traffic for received I-frames. This counter sets a specified value and decrements each time an I-frame is received. When this counter reaches 0 or the T2 timer expires, an acknowledgment is sent. Default is 1.

#### Receive Window (Rw)

Indicates the maximum number of unacknowledged sequentially numbered I-frames that an LLC can receive from a remote host.

#### Transmit Window (Tw)

Indicates the maximum number of I-frames that can be sent before receiving an RR.

#### Acks needed to increment Ww (Nw)

This field is set to a default value of 1.

### Set

Use the **set** command to configure the LLC.

**Attention:** Changing LLC parameters from the defaults can affect how the LLC protocol works.

#### Syntax:

```
set n2-max-retry count
      n3-frames-rcvd-before-ack count
```



nw-acks-to-inc-window *count*rw-receive-window *count*t1-reply-timer *seconds*t2-receive-ack-timer *seconds*ti-inactivity-timer *seconds*tw-transmit-window *count***n2-max-retry**

The maximum number of retries by LLC protocol. For example, N2 is the maximum number of times the LLC transmits an RR without receiving an acknowledgment when the inactivity timer expires. Default is 8. Minimum is 1. Maximum is 127.

**Example:**

```
set n2-max-retry
Max Retry value (N2) [8]?
```

**n3-frames\_rcvd-before-ack**

This value is used with the T2 timer to reduce acknowledgment traffic for received I-frames. Set this counter to a specified value. Each time an I-frame is received, this value decrements. When this counter reaches 0 or the T2 timer expires, an acknowledgment is sent. Default is 1. Minimum is 1. Maximum is 255.

**Example:**

```
set n3-frames_rcvd-before-ack
Number I-frames received before sending ACK(N3) [1]?
```

**rw-receive-window**

Indicates the maximum number of unacknowledged sequentially numbered I-frames that an LLC can receive from a remote LLC peer. This value must be equal to or less than 127.

**Example:**

```
set rw-receive-window
Receive Window (Rw), 127 Max. [2]?
```

**nw-acks-to-inc-ww**

This field is set to a default value of 1.

**t1-reply-timer**

This timer expires when the LLC fails to receive a required acknowledgment or response from the other LLC station. When this timer expires, an RR is sent with the poll bit set and T1 is started again. If the LLC receives no response after the configured maximum number of retries (N2), the link underneath is declared inoperative. Default is 1. Minimum is 1. Maximum is 256.

**Example:**

```
set t1-reply-timer
Reply Timer (T1) in sec. [1]?
```

**t2-receive-ack-timer**

This timer is used to delay sending of an acknowledgment for a received I-format frame. This timer is started when an I-frame is received. The timer is reset when an acknowledgment is sent. If this timer expires, LLC2 sends an acknowledgment as soon as possible. Set this value so that it is less than that of T1. This insures that the remote LLC2 peer receives the delayed acknowledgment before the T1 timer expires. Default is 1 (100 ms). Minimum is 1. Maximum is 2560.

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### Example:

```
set t2-receive-ack-timer
Receive Ack timer (T2) in 100 millisec. [1]?
```

**Note:** If this timer is set to 1 (the default) it will not run (for example, `n3-frames_rcvd-before-ack =1`).

### ti-inactivity-timer

This timer expires when the LLC does not receive a frame for a specified time period. When this timer expires the LLC transmits an RR until the other LLC responds or the N2 retry count is exceeded. Default is 30 seconds. Minimum is 1 second. Maximum is 256 seconds.

### Example:

```
set ti-inactivity-timer
Inactivity Timer (Ti) in sec. [30]?
```

### tw-transmit-window

Sets the maximum number of I-frames that can be sent before receiving an RR. Assuming that the other end of the LLC session can actually receive this many consecutive I-frames, and the router has enough heap memory to keep copies of these frames until an acknowledgment is received, increasing this value may increase the throughput. Default is 2. Minimum is 1. Maximum is 127.

### Example:

```
set tw-transmit-window
Transmit Window (Tw), 127 Max. [2]?
```

---

## Accessing the Interface Monitoring Process

Access the monitoring commands for the protocol you wish to monitor over LLC:

- Token Ring, as described in “Chapter 14. Configuring IEEE 802.5 Token-Ring Network Interfaces” on page 205
- Point-to-Point, as described in “Chapter 44. Configuring and Monitoring Point-to-Point Protocol Interfaces” on page 597
- Frame Relay, as described in “Chapter 42. Configuring and Monitoring Frame Relay Interfaces” on page 525
- FDDI, as described in “Chapter 16. Using FDDI” on page 221

Each of these prompt levels has an LLC command. Enter **LLC** to access the LLC monitoring commands to monitor LLC. When you are finished, enter **Exit** to return to the prompt level for the protocol you are monitoring.

---

## LLC Monitoring Commands

This section summarizes and then explains all of the LLC monitoring commands. These commands, shown in Table 32, let you monitor the LLC while passing packets over an SNA network.

*Table 32. LLC Monitoring Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Clear-counters	Clears all statistical counters.
List	Displays interface, SAP, and session information.

Table 32. LLC Monitoring Command Summary (continued)

Command	Function
Set	Allows the user to dynamically configure LLC parameters that are valid for the life of the session.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

## Clear-Counters

Use the **clear-counters** command to clear all the LLC statistical counters.

### Syntax:

**clear-counters**

## List

Use the **list** command to display interface, service access point (SAP), and session information.

### Syntax:

```
list                interface
                    sap . . .
                    session
```

### interface

Displays all SAPs opened on this interface.

#### Example:

```
list interface
SAP      Number of Sessions
F4       1
```

### sap sap\_number

Displays information for the specified SAP on the interface.

#### Example:

```
list sap
SAP value in hex (0FE) [1]? F4

Interface                0, TKR/0
Reply Timer(T1)          1 sec
Receive ACK Timer (T2)   100 millisec
Inactivity Timer (Ti)    30 sec
MAX Retry Value (N2)     8
MAX I-field Size (N1)    2052
Rcvd I-frames before ACK (N3) 1
Transmit Window Size (Tw) 2
Acks Needed to Inc Ww (Nw) 1

Frame                    Xmt    Rcvd
UI-frames                 4      5
TEST-frames               0      1
XID-frames                0      0
I-frames                  291    26
RR-frames                 81     291
RNR-frames                0      0
REJ-frames                0      0
SABME-frames              1      0
UA-frames                 0      1
DISC-frames               0      0
DM-frames                 0      0
FRMR-frames               0      0
I-frames discarded by LLC 0
I-frames Refused by LLC user 0

Cumulative number of sessions 1
Number of active sessions     1
```

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Session ID (int-sap-id)	Local MAC	Remote MAC	Remote SAP	State
00F40000	00:00:C9:08:41:DB	10:00:5A:F1:02:37	F4	OPENED

### **SAP value in hex (0FE)**

The SAP value of the session.

### **Interface**

The interface number and type over which the session is running.

### **Reply Timer (T1)**

Indicates the time it takes for this timer to expire when the LLC fails to receive an acknowledgment or response from the other LLC station.

### **Receive ACK Timer (T2)**

Indicates the time delay the LLC uses before sending an acknowledgment for a received I-frame.

### **Inactivity Timer (Ti)**

Indicates the time the LLC waits during inactivity before issuing an RR.

### **MAX Retry Value (N2)**

The maximum number of retries by the LLC protocol.

### **MAX I-field Size (N1)**

Maximum amount of data (in bytes) allowed in the I-field of an LLC2 frame.

### **Rcvd I-frame before ACK (N3)**

Indicates the value that is used with T2 timer to reduce acknowledgment traffic for received I-frames.

### **Transmit Window Size (Tw)**

Indicates the maximum number I-frames that can be sent before receiving an RR.

### **Acks Needed to Inc Ww (Nw)**

This field is set to a default value of 1.

### **Frames Xmt and Rcvd**

Counter that displays the total number of frame types transmitted (Xmt) and (Rcvd).

### **I-frames discarded by LLC**

Counter that displays the total number of I-frames discarded by the LLC, usually because the sequence number is out of sequence.

### **I-frames refused by LLC user**

Counter that displays the number of I-frames discarded by the software above the LLC. For example, DLSw (Data Link Switching).

### **Cumulative number of sessions**

The total number of sessions that were opened over this SAP.

### **Number of active sessions**

The total number of currently active sessions that are running over the interface.

### **Session ID (int-sap-id)**

The session ID for the monitoring interface.

### **Local MAC**

The router's LLC MAC address.

**Remote MAC**

The remote LLC's MAC address.

**Remote SAP**

The remote SAP of the LLC connection.

**Remote State**

The finite state(s) that results from interaction between the LLC peers. There are 21 states that are described below.

**Link\_Closed**

The remote LLC peer is not known to the local LLC peer and is considered as not existing.

**Disconnected**

The local LLC peer is known to the other peer. This LLC peer can send and receive XID, TEST, SABME, and DISC commands; and XID TEST, UA, and DM responses.

**Link\_Opening**

The state of the local LLC peer after sending a SABME or UA in response to a received SABME.

**Disconnecting**

The state of the local LLC after sending a DISC command to the remote LLC peer.

**FRMR\_Sent**

The local LLC peer has entered the frame reject exception state and has sent a FRMR response across the link.

**Link\_Opened**

The local LLC peer is in the data transfer phase.

**Local\_Busy**

The local LLC peer is unable to receive additional I-frames.

**Rejection**

A local LLC peer that has received one or more out-of-sequence I-frames.

**Checkpointing**

The local LLC peer has sent a poll to the remote LLC peer and is waiting for an appropriate response.

**CKPT\_LB**

A combination of checkpointing and local busy states.

**CKPT\_REJ**

A combination of the checkpointing and rejection states.

**Resetting**

The local LLC peer has received a SABME and is reestablishing the link.

**Remote\_Busy**

The state that occurs when an RNR is received from the remote LLC peer.

**LB\_RB**

A combination of local\_busy and remote\_busy states.

**REJ\_LB**

A combination of rejection and local\_busy states.

**REJ\_RB**

A combination of rejection and remote\_busy states.

## Monitoring LLC

### CKPT\_REJ\_LB

A combination of checkpointing, rejection, and local\_busy states.

### CKPT\_CLR

A combination state resulting from the termination of a local\_busy condition while the LLC peer is CKPT\_LB.

### CKPT\_REJ\_CLR

A combination state resulting from the transfer of an unconfirmed local busy clear while the link station is in the CKPT\_REJ\_LB state.

### REJ\_LB\_RB

A combination of the rejection, local\_busy, and remote\_busy states.

### FRMR\_Received

The local LLC peer has received an FRMR response from the remote LLC peer.

### Session

Displays information on the specified LLC session that is open on the interface.

#### Example:

```
list session
Session Id: [0]? 00-F4-0000

Interface0,                TKR/0
Remote MAC addr            10:00:5A:F1:02:37
Source MAC addr           00:00:C9:08:35:47
Remote SAP                 F4
Local SAP                 F4
RIF                       (089E 0101 0022 0010)
Access Priority            0
State                     LINK_OPENED
Replay Timer              1 sec
Receive ACK Timer (T2)    100 millisecc
Inactivity Timer (Ti)     30 sec
MAX I-field Size (N1)     2052
MAX Retry Value (N2)      8
Rcvd I-frames before ACK (N3) 1
Transmit Window Size (Tw) 2
Working Transmit Size (Ww) 2
Acks Needed to Inc Ww (Nw) 1
Current Send Seq (Vs)     9
Current Rcv Seq (Vr)     7
Last ACK'd sent frame (Va) 9
No. of frames in ACK pend q 0
No. of frames in Tx pend q 0
Local Busy                NO
Remote Busy               NO
Poll Retry count          8
Appl output flow stopped NO
Send process running      YES

Frame                      Xmt   Rcvd
I-frames                   1456  2678
RR-frames                   502   403
RNR-frames                  0     0
REJ-frames                  0     0
I-frames discarded by LLC  0
I-frames Refused by LLC user 0
```

#### Session Id

Indicates the session ID number.

#### Interface

Indicates the number of the interface over which this session is running.

#### Remote MAC addr

Indicates the MAC address of the remote LLC peer.

#### Source MAC addr

Indicates the MAC address of the local LLC.

**Remote SAP**

The remote side SAP of the LLC connection.

**Local SAP**

The local side SAP of the LLC connection.

**RIF** The actual RIF of the frame.

**Access Priority**

Priority of the packet. 07 for upper layer control.

**State** The finite state(s) that results from interaction between the LLC peers. Refer to the **list sap** command on page 237 for more information.

**Receive ACK timer (T2)**

Indicates the time delay the LLC uses before sending an acknowledgment for a received I-frame.

**Inactivity timer (Ti)**

Indicates the time the LLC waits during inactivity before issuing an RR.

**MAX I-field size (N1)**

Maximum size of the data field (in bytes) of a frame. Default is the size of the interface.

**MAX Retry Value (N2)**

The maximum number of times the LLC transmits an RR without receiving an acknowledgment

**Rcvd I-frames before ACK (N3)**

Indicates the value that is used with T2 timer to reduce acknowledgment traffic for received I-frames.

**Transmit window size (Tw)**

Indicates the maximum number of I-frames that can be sent before receiving an RR.

**Working transmit size (Ww)**

The maximum number of I-frames that are sent before receiving an RR.

**Acks Needed to Inc Ww (Nw)**

This field is set to a default value of 1.

**Current send seq (Vs)**

Send state variable (Ns value for the next I-frame to be transferred).

**Current Rcv seq (Vr)**

Receive state variable (next in-sequence Ns to be accepted).

**Last ACK'd sent frame (Va)**

Acknowledged state variable (last valid Nr received).

**No. of frames in ACK pend q**

Number of transmitted I-frames waiting for acknowledgment.

**No. of frames in transmit pend q**

Number of frames waiting to be transmitted.

**Local Busy**

The local side of the LLC connection is sending RNRs.

## Monitoring LLC

### Remote Busy

The remote side of the LLC is receiving RNRs.

### Poll Retry count

Indicates the current value of the retry of the counter (counts down) in the LLC protocol.

### Appl output flow stopped

The LLC has told the application to stop giving it outgoing data frames.

### Send process running

This process runs concurrently with all other frame actions and takes I-frames in the transmit queue and sends them.

### Frames Xmt and Rcvd

Displays the total number of frame types transmitted (Xmt) and (Rcvd).

### I-frames discarded by LLC

Counter that displays the total number of I-frames discarded by the LLC, usually because the sequence number is out of sequence.

### I-frames refused by LLC user

Counter that displays the number of I-frames discarded by the software above the LLC. For example, DLSw (Data Link Switching).

## Set

Use the **set** command to dynamically configure the LLC parameters on a current LLC session. Any changes that you make to the parameters are effective for the life of session. These parameters are the same as those listed in “Set” on page 234.

**Attention:** Changing LLC parameters from the default can affect how the LLC protocol works.

### Syntax:

```
set                n2-max_retry count  
                   n3-frames-rcvd-before-ack count  
                   nw-acks-to-inc-ww count  
                   t1-reply-timer seconds  
                   t2-receive-ack-timer seconds  
                   ti-inactivity-timer seconds  
                   tw-transmit-window seconds
```

### **n2-max\_retry**

The maximum number of retries by LLC protocol. For example, N2 is the maximum number of times the LLC transmits an RR without receiving an acknowledgment when the inactivity timer expires. Default is 8. Minimum is 1. Maximum is 127.

### **n3-frames-rcvd-before-ack**

This value is used with the T2 timer to reduce acknowledgment traffic for received I-frames. Set this counter to a specified value. Each time an I-frame is received, this value is decremented. When this counter reaches 0 or the T2 timer expires, an acknowledgment is sent. Default is 1. Minimum is 1. Maximum is 255.



**nw-acks-to-inc-ww**

This field is set to a default value of 1.

**t1-reply-timer**

This timer expires when the LLC fails to receive a required acknowledgment or response from the other LLC station. When this timer expires, an RR is sent with the poll bit set and T1 is started again. If the LLC receives no response after the configured maximum number of retries (N2), the link underneath is declared inoperative. Default is 1. Minimum is 1. Maximum is 256.

**t2-receive-ack-timer**

This timer is used to delay sending of an acknowledgment for a received I-format frame. This timer is started when an I-frame is received and reset when an acknowledgment is sent. If this timer expires, LLC2 sends an acknowledgment as soon as possible. Set this value so that it is less than that of T1. This insures that the remote LLC2 peer receives the delayed acknowledgment before the T1 timer expires. Default is 1 (100 ms). Minimum is 1. Maximum is 2560.

**Note:** If this timer is set to 1 (the default) it will not run (for example, **n3-frames-rcvd-before-ack=1**).

**ti-inactivity-timer**

This timer expires when the LLC does not receive a frame for a specified time period. When this timer expires the LLC transmits an RR until the other LLC responds or the N2 timer expires. Default is 30 seconds. Minimum is 1 second. Maximum is 256 seconds.

**tw-transmit-window**

Sets the maximum number of I-frames that can be sent before receiving an RR. Assuming that the other end of the LLC session can actually receive this many consecutive I-frames, and the router has enough heap memory to keep copies of these frames until an acknowledgment is received, increasing this value may increase the throughput. Default is 2. Minimum is 1. Maximum is 127.

## Monitoring LLC

---

## Chapter 19. Using the Ethernet Network Interface

This chapter describes how to use the Ethernet interface. It includes “Displaying Ethernet Statistics through the Interface Command”.

---

### Displaying Ethernet Statistics through the Interface Command

You can also use the **interface** command from the GWCON environment to display the following statistics.

```
+ interface 4
Nt Nt' Interface Slot-Port Self-Test Self-Test Maintenance
4 4 Eth/0 Slot: 4 Port: 1 Passed Failed Failed
Ethernet/IEEE 802.3 MAC/data-link on Ethernet interface
Physical address AA0004000318
PROM address 10005AFF0016
Microcode Level Uu17c

Input statistics:
failed, packet too long 0 failed, CRC error 1
failed, alignment error 0 failed, FIFO over-run 0
buffer full warnings 0 packets missed 1
internal mac rx errors 0

Output statistics:
initially deferred 12 single collision 1
multiple collisions 1 total collisions 4
failed, excess collisions 0 failed, FIFO under-run 0
failed, carrier check 0 CD heartbeat error 0
```

These statistics have the following meaning:

**Nt** Global network number.

**Nt'** This field is for the serial interface card. Disregard the output.

**Interface**

Interface name and its instance number.

**Port** Port number

**Slot** Slot number

**Self-Test: Passed**

Number of self-tests that succeeded.

**Self-Test: Failed**

Number of self-tests that failed.

**Maintenance: Failed**

Number of maintenance failures.

**Physical address**

The Ethernet address of the device currently in use. This may be the PROM address or an address overwritten by some other protocol.

**PROM address**

The permanent unique Ethernet address in the PROM for this Ethernet interface.

**Input statistics:**

**failed, packet too long or failed, frame too long**

The Failed, Packet Too Long counter increments when the interface

## Using Ethernet Network Interfaces

receives a packet that is larger than the maximum size of 1518 bytes for an Ethernet frame. This data is exported via SNMP as the dot3StatsFrameTooLongs counter.

### **failed, CRC error or failed, FCS (Frame Check Sequence) error**

The Failed, CRC (Cyclic Redundancy Check) Error counter increments when the interface receives a packet with a CRC error. This data is exported via SNMP as the dd3StatsFCSErrors counter.

### **failed, framing error or failed, alignment error**

The Failed, Framing Error counter increments when the interface receives a packet whose length in bits is not a multiple of eight.

### **failed, FIFO over-run or failed, FIFO overrun**

The Failed, FIFO (First In, First Out) Overrun counter increments when the Ethernet chipset is unable to store bytes in the local packet buffer as fast as they come off the wire.

### **buffer full warnings**

The Buffer Full Warnings counter increments each time the local packet buffer is full.

### **packets missed**

The Packets Missed counter increments when the interface attempts to receive a packet, but the local packet buffer is full. This error indicates that the network has more traffic than the interface can handle.

### **internal mac rcv errors**

Receive errors that are not late, excessive, or carrier check collisions. This data is exported via SNMP as the dot3StatsInternalMacReceiveErrors counter. This statistic is the sum of the FIFO Overruns.

### **Output statistics:**

#### **initially deferred or deferred transmission**

The Initially Deferred counter increments when the carrier sense mechanism detects line activity causing the interface to defer transmission. This data is exported via SNMP as the dot3StatsDeferredTransmissions counter.

#### **single collision**

The Single Collision counter increments when a packet has a collision on the first transmission attempt, and then successfully sends the packet on the second transmission attempt. This data is exported via SNMP as the dot3StatsSingleCollisionFrames counter.

#### **multiple collisions**

The Multiple Collisions counter increments when a packet has multiple collisions before being successfully transmitted. This data is exported via SNMP as the dot3MultipleCollisionFrames counter.

#### **total collisions**

The Total Collisions counter increments by the number of collisions a packet incurs.

#### **failed, excess collisions**

The Failed, Excess Collisions counter increments when a packet transmission fails due to 16 successive collisions. This error indicates a high volume of network traffic or hardware problems with the network. This data is exported via SNMP as the dot3StatsExcessiveCollisions counter.

### **failed, FIFO underrun**

The Failed, FIFO Underrun counter increments when packet transmission fails due to the inability of the interface to retrieve packets from the local packet buffer fast enough to transmit them onto the network.

### **failed, carrier check or failed, carrier sense error**

The Failed, Carrier Check counter increments when a packet collides because carrier sense is disabled. This error indicates a problem between the interface and its Ethernet transceiver. This data is exported via SNMP as the dot3StatsCarrierSenseErrors counter.

### **CD heartbeat error or SQE test error**

The CD (Collision Detection) Heartbeat Error or SQE (Signal Quality Error) counter increments when the interface sends a packet but detects that the transceiver has no heartbeat. The packet is treated as successfully transmitted because some transceivers do not generate heartbeats. This data is exported via SNMP as the dot3StatsSQETestErrors counter.

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---

## Chapter 20. Configuring and Monitoring the Ethernet Network Interface

This chapter describes Ethernet interface configuration and operational commands. It includes the following sections:

- “Accessing the Ethernet Interface Operating Process” on page 251
- “Ethernet Interface Monitoring Commands” on page 251
- “Ethernet Dynamic Reconfiguration Support” on page 252

---

### Accessing the Ethernet Interface Configuration Process

Use the following procedure to access the configuration process. This process gives you access to an Ethernet interface’s *configuration* process.

1. At the OPCODE prompt, enter **talk 6**. (For more detail on this command, see “What is the OPCODE Process?” on page 31.) For example:

```
* talk 6
Config>
```

The CONFIG prompt (Config>) displays on the console. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the CONFIG prompt, enter the **list devices** command to display the network interface numbers for which the router is currently configured.
3. Record the interface numbers.
4. Enter the **network** command and the number of the Ethernet interface you want to configure. For example:

```
Config> network 0
ETH Config>
```

The Ethernet configuration prompt (ETH Config>), is displayed.

---

### Ethernet Configuration Commands

This section summarizes and then explains the Ethernet configuration commands. Enter the commands at the ETH config> prompt.

Table 33. Ethernet Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Connector-Type	Sets the connector type.
IP-Encapsulation	Sets the IP encapsulation as Ethernet (type X'0800'), IEEE (802.3 with SNAP) or both.
List	Displays the current connector-type, NetWare IPX encapsulation, and IP encapsulation.
Physical-Address	Sets the physical MAC address.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Connector-Type

Use the **connector-type** command to set the connector type. 2216s support AUI (10BASE5) and RJ-45 (10BASE-T) connectors, and auto-config options.

## Ethernet Configuration Commands (Talk 6)

### Syntax:

connector-type *name*

## IP-Encapsulation

Use the **IP-encapsulation** command to select Ethernet (Ethernet type X'0800'), IEEE 802.3 (Ethernet 802.3 with SNAP), or both. The default is Ethernet.

The option **both** enables the 2216 to use Ethernet encapsulation to transmit to hosts that have Ethernet encapsulation and to use IEEE 802.3 encapsulation to transmit to hosts that have IEEE 802.3 encapsulation. If your Ethernet LAN includes some hosts that use one type of encapsulation and some that use the other, entering **both** enables all of them to communicate.

The option **both** applies only to unicast frames. If you enter **both**, you are prompted to enter either **ethernet** or **ieee-802.3** for broadcast and multicast frames.

### Syntax:

IP-encapsulation

- ethernet
- ieee-802.3
- both

### Example:

```
Eth Config [1]>ip-encapsulation both
How would you like IP broadcast/multicast frames to be sent (ETHER/IEEE-802.3) [ETHER]?
```

## List

Use the **list** command to display the current configuration for the Ethernet interface, including the connector-type, IPX encapsulation type, and IP encapsulation type.

### Syntax:

list all

### Example:

```
list all
Connector type:      AUI (10BASE5)
IP Encapsulation:   ETHER
MAC Address:        023456789A56
```

## Physical-Address

Use the **physical-address** command to set the physical (MAC) address.

**Syntax:** physical-address *address*

### physical-address

This command lets you indicate whether you want to define a locally administered address for the Ethernet interface's MAC sublayer address, or use the default burned-in address (indicated by all zeros). The MAC sublayer address is the address that the Ethernet interface uses to receive and transmit frames.

**Note:** Pressing **Enter** leaves the value the same. Entering **0** causes the router to use the burned-in address. The default is to use the burned-in address.



## Ethernet Configuration Commands (Talk 6)

**Valid Values:** Any 12-digit hexadecimal address.

**Default Value:** burned-in address (indicated by all zeros).

**Example:**

`physical-address`

MAC address in 00:00:00:00:00:00 form []? 12:15:00:FA:00:FE

---

## Accessing the Ethernet Interface Operating Process

To monitor information related to the Ethernet Network Interface, access the interface monitoring process by doing the following:

1. At the OPCON prompt, enter **talk 5**. For example:

```
* talk 5
```

The GWCON prompt (+) is displayed on the console. If the prompt does not appear when you first enter GWCON, press **Return** again.

2. At the GWCON prompt, enter the **configuration** command to see the protocols and networks for which the router is configured. For example:

```
+ configuration
```

See page “Configuration” on page 112 for sample output of the **configuration** command.

3. Enter the **network** command and the number of the Ethernet interface. In this example:

```
+ network 0  
ETH>
```

The Ethernet monitoring prompt is displayed. You can now view information about the Ethernet interface by entering monitoring commands.

---

## Ethernet Interface Monitoring Commands

This section summarizes and explains the Ethernet monitoring commands. Enter commands at the ETH> prompt. Table 34 lists the monitoring commands.

*Table 34. Ethernet monitoring command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Collisions	Displays collision statistics for the specified Ethernet interface.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## Collisions

This command shows the counts of transmissions for packets that incurred collisions before successful transmission. Counters are given for packets sent after the collision XXXXx packets sent after 15 collisions. Increasing numbers of packets transmitting with collisions and higher numbers of collision per packet are signs of transmitting onto a busy Ethernet.

These counters are cleared by the OPCON **clear** command. This data is exported via SNMP as the dot3CollTable counter.

## Ethernet Interface Monitoring Commands (Talk 5)

### Syntax:

#### collisions

### Example:

```
Eth> coll
Transmitted with 1 collisions:0
Transmitted with 2 collisions:0
Transmitted with 3 collisions:0
Transmitted with 4 collisions:0
Transmitted with 5 collisions:0
Transmitted with 6 collisions:0
Transmitted with 7 collisions:0
Transmitted with 8 collisions:0
Transmitted with 9 collisions:0
Transmitted with 10 collisions:0
Transmitted with 11 collisions:0
Transmitted with 12 collisions:0
Transmitted with 13 collisions:0
Transmitted with 14 collisions:0
Transmitted with 15 collisions:0
```

---

## Ethernet Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

Ethernet supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

### GWCON (Talk 5) Activate Interface

Ethernet supports the GWCON (Talk 5) **activate interface** command with no restrictions.

All Ethernet interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

### GWCON (Talk 5) Reset Interface

Ethernet supports the GWCON (Talk 5) **reset interface** command with no restrictions.

All Ethernet interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.

---

## Chapter 21. Using the 10/100-Mbps Ethernet Network Interface

This chapter describes how to use the 10/100-Mbps Ethernet interface. It includes the following sections:

- “Displaying 10/100-Mbps Ethernet Statistics”
- “Auto-negotiation on the 10/100-Mbps Ethernet Interface” on page 260
- “Configuring Values Other than Auto for Duplex” on page 260
- “Configurations That May Result in Link Activation Failure on the IBM 2216” on page 261
- “Configurations That May Result in Mismatched Duplex Modes During Operation” on page 261

---

### Displaying 10/100-Mbps Ethernet Statistics

You can use the **interface** command from the GWCON environment to display the following statistics.

```
+i 0
Net  Net'  Interface  Slot-Port          Self-Test  Self-Test  Maintenance
0    0      Eth/0      Slot: 1  Port: 1          Passed    Failed    Failed
                                1          0          0

Ethernet/IEEE 802.3 MAC/data-link on 10/100-Ethernet interface

Encapsulation type      Ethernet
Physical address        002035030008
PROM address            002035030008
Actual address          002035030008
Adapter Level          0
Configured Duplex:     Auto-Negotiation
Actual Duplex:         Half Duplex
Configured Speed:      Auto-Negotiation
Actual Speed:          100 Mbps

Input statistics:
  failed, packet too long      0  failed, CRC error          0
  failed, alignment error      0  failed, receive overflow   0
  *receive collision           0  *missed frame              0
  **frames filtered            0  receive underrun          0
  receive error                0

Output statistics:
  one retry                    0  single collision           0
  multiple collisions          0  failed, transmit underflow 0
  failed, excess collisions    0  failed, loss of carrier    0
  late collisions              0  more than one retry        0
  buffer error                 0  total collisions           0
  excessive deferral           0  deferred                   0
  memory error                 0

Connection statistics:
  disconnects                  0  false carrier sense        0

* cannot be cleared.
** cleared automatically when read.
```

These statistics have the following meaning:

**Nt** Global network number.

**Nt'** This field is for the serial interface card. Disregard the output.

**Interface**

Interface name and its instance number.

**Self-Test: Passed**

Number of self-tests that succeeded.

## Using 10/100-Mbps Ethernet Network Interfaces

### **Self-Test: Failed**

Number of self-tests that failed.

### **Maintenance: Failed**

Number of maintenance failures.

### **Physical address**

The Ethernet address of the device currently in use. This may be the PROM address or an address overwritten by some other protocol.

### **PROM address**

The permanent unique Ethernet address in the PROM for this Ethernet interface.

### **Link Status**

The current link status, either up or down.

### **Configured duplex**

The value configured for duplex. Values can be Half Duplex, Full Duplex, or Auto-Negotiation. This value applies to 10/100-Mbps Ethernet only.

### **Actual duplex**

The value at which the adapter is presently operating. It might be different from the value configured, depending on the switch capability. If the adapter is not Up, the value displayed will be *Unknown*. Otherwise the value can be Half Duplex or Full Duplex.

Whenever the link partner (switch or hub) does not participate during the negotiation phase, \*\*\* will follow the actual duplex mode value. When \*\*\* is indicated the operational duplex value should be verified on the switch or hub for consistency.

Most hubs (unlike switches) can only support half-duplex mode, and are not capable of negotiation. As such the \*\*\* indication will usually be displayed when the interface is connected to a hub.

A message will also be logged via the ELS system whenever a possibility of a mis-match in duplex mode exists.

**Note:** If the link partner (switch or hub) to which the interface is connected does not respond during the negotiation phase, the two may result in operating in different duplex modes. That is, the interface may be operating in half-duplex, while the switch port is operating in full duplex mode. A mismatch in the duplex mode can result in severe performance degradation. See "10/100-Mbps Ethernet Configuration Commands" on page 263 for important information regards speed and duplex configurations.

### **Configured speed**

The value configured for speed. Values can be 10 Mbps, 100 Mbps, or Auto-Negotiation.

### **Actual speed**

The speed at which the adapter is presently operating. If the adapter is not Up, the value displayed will be *Unknown*. Otherwise the value can be 10 Mbps or 100 Mbps .

### **Input statistics:**

#### **failed, packet too long or failed, frame too long**

The Failed, Packet Too Long counter increments when the interface

## Using 10/100-Mbps Ethernet Network Interfaces

receives a packet that is larger than the maximum size of 1518 bytes for an Ethernet frame. This data is exported via SNMP as the dot3StatsFrameTooLongs counter.

### **failed, CRC error or failed, FCS (Frame Check Sequence) error**

The Failed, CRC (Cyclic Redundancy Check) Error counter increments when the interface receives a packet with a CRC error. This data is exported via SNMP as the dd3StatsFCSErrors counter.

### **failed, alignment error**

The Failed, Framing Error counter increments when the interface receives a packet where the length in bits is not a multiple of eight. This value applies to 10/100-Mbps Ethernet only.

### **failed, receive overflow**

Overflow error indicates that the receiver has lost all or part of the incoming frame, due to an inability to move data from the receive FIFO into memory buffer before the internal FIFO overflowed.

### **receive collision**

Indicates the total number of collisions encountered by the receiver support on the adapter.

**Note:** This counter cannot be cleared by the **clear statistics** command because it is maintained on the adapter. The **test network** command is the only way to reset this counter.

### **missed frame**

Indicates the number of incoming receive frames lost due to unavailability of a receive buffer in the system. This error indicates that the system is not processing received frames as fast as they are being received from the local network.

**Note:** This counter cannot be cleared by the **clear statistics** command because it is maintained on the adapter. The **test network** command is the only way to reset this counter.

### **frames filtered**

Indicates the number of incoming frames that were discarded by the adapter. This counter is updated only when bridging is enabled.

**Note:** This counter is maintained on the adapter, and is cleared every time it is read. This counter will be cleared by the **interface statistics** and the **test network** commands.

### **receive underrun**

Indicates the number of times the adapter did not have a second buffer to store a long frame (requiring more than one buffer).

### **receive error**

This hardware counter is incremented for each packet in which a receive error is detected. If there are one or more receiver error conditions during a valid packet reception (that is, no collision occurred during packet reception), the counter is incremented once at the end of packet reception.

### **Output statistics:**

#### **single collision**

The Single Collision counter increments when a packet has a collision on the first transmission attempt, and then successfully sends the packet on

## Using 10/100-Mbps Ethernet Network Interfaces

the second transmission attempt. This data is exported via SNMP as the dot3StatsSingleCollisionFrames counter. This value applies to 10/100-Mbps Ethernet only.

### **multiple collisions**

The Multiple Collisions counter increments when a packet has multiple collisions before being successfully transmitted. This data is exported via SNMP as the dot3MultipleCollisionFrames counter. This value applies to 10/100-Mbps Ethernet only.

### **failed, transmit underflow**

Transmit underrun indicates that transmitter has truncated a message because it could not read data from the memory fast enough. It also indicates that the FIFO on the adapter has emptied out before the end of the frame was reached. IFO into memory buffer before the internal FIFO overflowed.

### **failed, excess collisions**

The Failed, Excess Collisions counter increments when a packet transmission fails due to 16 successive collisions. This error indicates a high volume of network traffic or hardware problems with the network. This data is exported via SNMP as the dot3StatsExcessiveCollisions counter. This value applies to 10/100-Mbps Ethernet only.

### **failed, loss of carrier**

Loss of carrier is set when the carrier is lost during transmission. The adapter does not retry upon loss of carrier. It will continue to transmit the whole frame until done.

### **late collisions**

A late collision indicates that a collision has occurred after the first channel slot time has elapsed. The adapter does not retry on late collisions.

### **more than one retry**

More than one retry indicates that more than one retry was needed to transmit a frame.

### **buffer error**

Buffer error occurs if there is a memory corruption problem in the system, or under certain FIFO underflow conditions on the adapter.

### **total collisions**

The Total Collisions counter increments by the number of collisions a packet incurs.

### **excessive deferral**

Excessive deferral indicates that the transmitter on the adapter has experienced Excessive Deferral on this a transmit frame, where Excessive Deferral is defined in the ISO 8802-3 (IEEE/ANSI 802.3) standard.

### **deferred**

Deferred indicates the number of times the adapter had to defer while trying to transmit a frame. This condition occurs if the DMA channel is busy when the adapter is ready to transmit.

### **memory error**

Memory errors occur when the adapter is not given access to the system interface bus within the programmable length of time. This error will normally occur during transmit operations, indicating transmit underrun.

### **Connection statistics**

## Using 10/100-Mbps Ethernet Network Interfaces

### **disconnects**

Indicates the number of times that the interface and its link partner (switch or hub) were disconnected from each other.

### **false carrier sense**

Indicates the number of times the interface encountered a false carrier event. The counter freezes when full (at X'FFFF').

These statistics have the following meaning:

**Nt** Global network number.

**Nt'** This field is for the serial interface card. Disregard the output.

### **Interface**

Interface name and its instance number.

### **Self-Test: Passed**

Number of self-tests that succeeded.

### **Self-Test: Failed**

Number of self-tests that failed.

### **Maintenance: Failed**

Number of maintenance failures.

### **Physical address**

The Ethernet address of the device currently in use. This may be the PROM address or an address overwritten by some other protocol.

### **PROM address**

The permanent unique Ethernet address in the PROM for this Ethernet interface.

### **Actual address**

### **Configured duplex**

The value configured for duplex. Values can be Half Duplex, Full Duplex, or Auto-Negotiation. This value applies to 10/100-Mbps Ethernet only.

### **Actual duplex**

The value at which the adapter is presently operating. It might be different from the value configured, depending on the switch capability. If the adapter is not Up, the value displayed will be *Unknown*. Otherwise the value can be Half Duplex or Full Duplex.

Whenever the link partner (switch or hub) does not participate during the negotiation phase, \*\*\* will follow the actual duplex mode value. When \*\*\* is indicated the operational duplex value should be verified on the switch or hub for consistency.

Most hubs (unlike switches) can only support half-duplex mode, and are not capable of negotiation. As such the \*\*\* indication will usually be displayed when the interface is connected to a hub.

A message will also be logged via the ELS system whenever a possibility of a mis-match in duplex mode exists.

**Note:** If the link partner (switch or hub) to which the interface is connected does not respond during the negotiation phase, the two may result in operating in different duplex modes. That is, the interface may be operating in half-duplex, while the switch port is operating in full duplex mode. A mismatch in the duplex mode can result in severe

## Using 10/100-Mbps Ethernet Network Interfaces

performance degradation. See “10/100-Mbps Ethernet Configuration Commands” on page 263 for important information regards speed and duplex configurations.

### Configured speed

The value configured for speed. Values can be 10 Mbps, 100 Mbps, or Auto-Negotiation. This value applies to 10/100-Mbps Ethernet only.

### Actual speed

The speed at which the adapter is presently operating. If the adapter is not Up, the value displayed will be *Unknown*. Otherwise the value can be 10 Mbps or 100 Mbps .

### Input statistics:

#### failed, packet too long or failed, frame too long

The Failed, Packet Too Long counter increments when the interface receives a packet that is larger than the maximum size of 1518 bytes for an Ethernet frame. This data is exported via SNMP as the dot3StatsFrameTooLongs counter.

#### failed, CRC error or failed, FCS (Frame Check Sequence) error

The Failed, CRC (Cyclic Redundancy Check) Error counter increments when the interface receives a packet with a CRC error. This data is exported via SNMP as the dd3StatsFCSErrors counter.

#### failed, alignment error

The Failed, Framing Error counter increments when the interface receives a packet where the length in bits is not a multiple of eight. This value applies to 10/100-Mbps Ethernet only.

#### failed, receive overflow

Overflow error indicates that the receiver has lost all or part of the incoming frame, due to an inability to move data from the receive FIFO into memory buffer before the internal FIFO overflowed.

#### receive collision

Indicates the total number of collisions encountered by the receiver support on the adapter.

**Note:** This counter cannot be cleared by the **clear statistics** command because it is maintained on the adapter. The **test network** command is the only way to reset this counter.

#### missed frame

Indicates the number of incoming receive frames lost due to unavailability of a receive buffer in the system. This error indicates that the system is not processing received frames as fast as they are being received from the local network.

**Note:** This counter cannot be cleared by the **clear statistics** command because it is maintained on the adapter. The **test network** command is the only way to reset this counter.

#### frames filtered

Indicates the number of incoming frames that were discarded by the adapter. This counter is updated only when bridging is enabled.

**Note:** This counter is maintained on the adapter, and is cleared every time it is read. This counter will be cleared by the **interface statistics** and the **test network** commands.



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### **receive underrun**

Indicates the number of times the adapter did not have a second buffer to store a long frame (requiring more than one buffer).

### **receive error**

This hardware counter is incremented for each packet in which a receive error is detected. If there are one or more receiver error conditions during a valid packet reception (that is, no collision occurred during packet reception), the counter is incremented once at the end of packet reception.

### **Output statistics:**

#### **one retry**

Indicates that exactly one retry was needed to transmit a frame. This data is exported via SNMP as the dot3StatsDeferredTransmissions counter. This value applies to 10/100-Mbps Ethernet only.

#### **single collision**

The Single Collision counter increments when a packet has a collision on the first transmission attempt, and then successfully sends the packet on the second transmission attempt. This data is exported via SNMP as the dot3StatsSingleCollisionFrames counter. This value applies to 10/100-Mbps Ethernet only.

#### **multiple collisions**

The Multiple Collisions counter increments when a packet has multiple collisions before being successfully transmitted. This data is exported via SNMP as the dot3MultipleCollisionFrames counter. This value applies to 10/100-Mbps Ethernet only.

#### **failed, transmit underflow**

Transmit underrun indicates that transmitter has truncated a message because it could not read data from the memory fast enough. It also indicates that the FIFO on the adapter has emptied out before the end of the frame was reached. IFO into memory buffer before the internal FIFO overflowed.

#### **failed, excess collisions**

The Failed, Excess Collisions counter increments when a packet transmission fails due to 16 successive collisions. This error indicates a high volume of network traffic or hardware problems with the network. This data is exported via SNMP as the dot3StatsExcessiveCollisions counter. This value applies to 10/100-Mbps Ethernet only.

#### **failed, loss of carrier**

Loss of carrier is set when the carrier is lost during transmission. The adapter does not retry upon loss of carrier. It will continue to transmit the whole frame until done.

#### **late collisions**

A late collision indicates that a collision has occurred after the first channel slot time has elapsed. The adapter does not retry on late collisions.

#### **more than one retry**

More than one retry indicates that more than one retry was needed to transmit a frame.

#### **buffer error**

Buffer error occurs if there is a memory corruption problem in the system, or under certain FIFO underflow conditions on the adapter.

## Using 10/100-Mbps Ethernet Network Interfaces

### **total collisions**

The Total Collisions counter increments by the number of collisions a packet incurs.

### **excessive deferral**

Excessive deferral indicates that the transmitter on the adapter has experienced Excessive Deferral on this a transmit frame, where Excessive Deferral is defined in the ISO 8802-3 (IEEE/ANSI 802.3) standard.

### **deferred**

Deferred indicates the number of times the adapter had to defer while trying to transmit a frame. This condition occurs if the DMA channel is busy when the adapter is ready to transmit.

### **memory error**

Memory errors occur when the adapter is not given access to the system interface bus within the programmable length of time. This error will normally occur during transmit operations, indicating transmit underrun.

### **Connection statistics**

#### **disconnects**

Indicates the number of times that the interface and its link partner (switch or hub) were disconnected from each other.

#### **false carrier sense**

Indicates the number of times the interface encountered a false carrier event. The counter freezes when full (at X'FFFF').

---

## Auto-negotiation on the 10/100-Mbps Ethernet Interface

Specifying values other than *auto* for speed or duplex on the 10/100-Mbps Ethernet interface or its link partner (switch port) can result in duplex mode mismatch or link activation failures.

Link activation failures due to configuration mismatches will occur on the IBM 2216 whenever the speed configured at both ends are not identical.

When either speed or duplex value is *auto-negotiate*, both speed and duplex will be negotiated with the link partner and its configured speed or duplex will be used.

---

## Configuring Values Other than Auto for Duplex

The IBM 2216 10/100-Mbps Ethernet interfaces will alert you whenever there is a possibility of a mismatch in the duplex mode between the switch and the router. When auto-negotiation is not configured on both ends, there is no definite way for either end to determine the duplex mode in use at the remote end, and the switch and the router interface can be operating with non-identical duplex modes.

Depending on the switch implementation, the switch port may operate at half duplex, when you have configured full duplex. As such, there is always a possibility of a mismatch to occur between the switch port and the router interface. The IBM 2216 will alert you whenever there is such a possibility, but some switches do not give such an indication.

## Configurations That May Result in Link Activation Failure on the IBM 2216

The primary cause of the link activation failure is mis-matched speeds.

To avoid link activation failure, configure *auto* for speed and duplex on the IBM 2216 and the switch port.

**Note:** These results may vary depending on the switch manufacturer and model.

Table 35. Configurations That May Result in Link Failure on the IBM 2216

IBM 2216	Hub/Switch
Auto 10	HDX* 100
Auto 10	FDX* 100
Auto 100	HDX 10
Auto 100	FDX 10
HDX 10	HDX 100
HDX 10	FDX 100
HDX 100	HDX 10
HDX 100	FDX 10
FDX 10	HDX 100
FDX 10	FDX 100
FDX 100	HDX 10
FDX 100	FDX 10

\* HDX = Half Duplex    FDX = Full Duplex

## Configurations That May Result in Mismatched Duplex Modes During Operation

The primary cause of the mismatched duplex modes is the disabling of auto-negotiation on the switch port and/or the IBM 2216 interface.

## Using 10/100-Mbps Ethernet Network Interfaces

To avoid mismatches in duplex mode, configure *auto* for speed and duplex on the IBM 2216 and the switch port.

**Note:** These results may vary depending on the switch manufacturer and model.

*Table 36. Configurations That May Result in Mismatched Duplex Modes During Operation*

Configuration		Result	
IBM 2216	Hub/Switch	IBM 2216	Hub/Switch
Auto Auto	FDX* 10	HDX* 10	FDX 10
Auto Auto	FDX 100	HDX 100	FDX 100
HDX Auto	FDX 10	HDX 10	FDX 10
HDX Auto	FDX 100	HDX 100	FDX 100
Auto 10	FDX 10	HDX 10	FDX 10
Auto 100	FDX 100	HDX 100	FDX 100
HDX 10	FDX 10	HDX 10	FDX 10
FDX Auto	HDX 10	FDX 10	HDX 10
FDX Auto	HDX 100	FDX 100	HDX 100
HDX 100	FDX 100	HDX 100	FDX 100
FDX 10	HDX 10	FDX 10	HDX 10
FDX 100	HDX 100	FDX 100	HDX 100

\* HDX = Half Duplex    FDX = Full Duplex

---

## Chapter 22. Configuring and Monitoring the 10/100-Mbps Ethernet Network Interface

This chapter describes the 10/100-Mbps Ethernet interface configuration and operational commands. It includes the following sections:

- “Accessing the Interface Configuration Process”
- “10/100-Mbps Ethernet Configuration Commands”
- “Accessing the Ethernet Interface Monitoring Process” on page 266
- “10/100-Mbps Ethernet Interface Monitoring Commands” on page 267
- “Ethernet Dynamic Reconfiguration Support” on page 267

---

### Accessing the Interface Configuration Process

Use the following procedure to access the configuration process. This process gives you access to an Ethernet interface’s *configuration* process.

1. At the OPCODE prompt, enter **configuration**. (For more detail on this command, refer to “What is the OPCODE Process?” on page 31.) For example:

```
* configuration
Config>
```

The CONFIG prompt (Config>) displays on the console. If the prompt does not appear when you first enter configuration, press **enter** again.

2. At the CONFIG prompt, enter the **list devices** command to display the network interface numbers for which the device is currently configured.
3. Record the interface numbers.
4. Enter the **network** command and the number of the Ethernet interface you want to configure. For example:

```
Config> network 0
Ethernet interface configuration
ETH Config>
```

The Ethernet configuration prompt (ETH Config>), is displayed.

---

### 10/100-Mbps Ethernet Configuration Commands

This section describes the 10/100-Mbps Ethernet configuration commands. Enter the commands at the ETH config> prompt.

Table 37. Ethernet Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Duplex	Sets the duplex mode. (For 10/100-Mbps Ethernet only.)
IP-Encapsulation	Sets the IP encapsulation as Ethernet (type X'0800'), IEEE (802.3 with SNAP), or both.
List	Displays the current connector-type, and IP encapsulation.
Physical-Address	Sets the physical MAC address.
Speed	Sets the link speed.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## Configuring Ethernet Network Interfaces

### Duplex

Use the **duplex** command to set the duplex mode. This command is for 10/100-Mbps Ethernet only.

**Note:** The default value of *auto* is recommended. The value **half-duplex** or **full-duplex** should be specified only if auto-negotiation does not result in successful activation of the interface or desired duplex mode. Note when you see the command syntax that the command for half-duplex or full-duplex is written with an underline between the words, for example, *half\_duplex*.

If a value other than *auto* is specified, ensure that the same value is configured on the switch port. After configuring the switch port to match the duplex specified on the 10/100-Mbps Ethernet interface, disable and test the interface.

Verify that the actual duplex mode shown on the interface status panel matches the operational value on the switch port.

The interface may enter the Up state with mismatched duplex mode. Operating with mismatched duplex modes on the interface and switch port can cause severe performance degradation.

See “Configuring Values Other than Auto for Duplex” on page 260 for information about duplex mode.

#### Syntax:

```
duplex                half_duplex
                    full_duplex
                    auto
```

#### Half\_duplex

The interface will not transmit while receiving or receive while transmitting.

#### Full\_duplex

The interface will transmit and receive simultaneously.

**Auto** The interface will automatically select half duplex or full duplex depending on the link partner’s capability.

### IP-Encapsulation

Use the **IP-encapsulation** command to select Ethernet (Ethernet type X'0800'), IEEE 802.3 (Ethernet 802.3 with SNAP), or both. The default is Ethernet.

The option **both** enables the 2216 to use Ethernet encapsulation to transmit to hosts that have Ethernet encapsulation and to use IEEE 802.3 encapsulation to transmit to hosts that have IEEE 802.3 encapsulation. If your Ethernet LAN includes some hosts that use one type of encapsulation and some that use the other, entering **both** enables all of them to communicate.

The option **both** applies only to unicast frames. If you enter **both**, you are prompted to enter either **ethernet** or **ieee-802.3** for broadcast and multicast frames.

#### Syntax:

```
IP-encapsulation
```

## Configuring Ethernet Network Interfaces

- ethernet
- ieee-802.3
- both

### Example:

```
Eth Config [1]>ip-encapsulation both
How would you like IP broadcast/multicast frames to be sent (ETHER/IEEE-802.3) [ETHER]?
```

## List

Use the **list** command to display the current configuration for the 10/100-Mbps Ethernet interface.

### Syntax:

```
list all
```

### Example:

```
list all
Eth Config [2]>list all
Connector type:      RJ45 (10BASET)
IP Encapsulation:   ETHER
MAC Address:        023456789A56
```

## Physical-Address

Use the **physical-address** command to set the physical (MAC) address.

### Syntax:

```
physical-address address
```

### physical-address

This command lets you indicate whether you want to define a locally administered address for the Ethernet interface's MAC sublayer address, or use the default burned-in address (indicated by all zeros). The MAC sublayer address is the address that the Ethernet interface uses to receive and transmit frames.

**Note:** Pressing **Enter** leaves the value the same. Entering **0** causes the device to use the burned-in address. The default is to use the burned-in address.

**Valid Values:** Any 12-digit hexadecimal address.

**Default Value:** burned-in address (indicated by all zeros).

### Example:

```
physical-address
MAC address in 00:00:00:00:00:00 form []? 12:15:00:FA:00:FE
```

## Speed

Use the **speed** command to set the speed used by this interface.

**Note:** For 10/100-Mbps Ethernet, the default value of *auto* is recommended. The values of **ten** and **hundred** should be specified only if auto-negotiation does not result in successful activation of the interface or desired speed.

## Configuring Ethernet Network Interfaces

If a value other than *auto* is specified, ensure that the same value is configured on the switch port. After configuring the switch port to match the speed specified on the 10/100-Mbps Ethernet interface, disable and test the interface.

If the interface and switch (or hub) port are not configured for identical speed, the interface will not attain the Up state.

See “Auto-negotiation on the 10/100-Mbps Ethernet Interface” on page 260 for information about auto-negotiation.

### Syntax:

```
speed                _ten
                       _hundred
                       _auto
```

**Ten** The 10/100 Mbps interface will operate at 10 Mbps.

### Hundred

The 10/100 Mbps interface will operate at 100 Mbps

**Auto** The 10/100 Mbps interface will automatically select the speed (10 Mbps or 100 Mbps) depending on the link partner’s capability.

---

## Accessing the Ethernet Interface Monitoring Process

To monitor information related to the 10/100-Mbps Ethernet Network Interface, access the interface monitoring process by doing the following:

1. At the OPCON prompt, enter **console**. For example:

```
* console
```

The GWCON prompt (+) is displayed on the console. If the prompt does not appear when you first enter GWCON, press **enter** again.

2. At the GWCON prompt, enter the **configuration** command to see the protocols and networks for which the device is configured. For example:

```
+ configuration
```

See “Configuration” on page 112 for sample output of the **configuration** command.

3. Enter the **network** command and the number of the Ethernet interface as shown in the following example:

```
+ network 0
ETH>
```

The Ethernet monitoring prompt is displayed. You can now view information about the Ethernet interface by entering monitoring commands.



## 10/100-Mbps Ethernet Interface Monitoring Commands

This section summarizes the 10/100-Mbps Ethernet monitoring commands. Enter commands at the ETH> prompt.

Table 38. Ethernet Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Collisions	Displays collision statistics for the specified Ethernet interface.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Collisions

This command displays the counts of transmissions for packets that incurred collisions before successful transmission. Counters are displayed for packets sent after 15 collisions. An increased number of packets transmitted with collisions and higher numbers of collisions per packet are signs of transmitting onto a busy Ethernet.

These counters are cleared by the OPCON **CLEAR** command. This data is exported via SNMP as the dot3CollTable counter.

#### Syntax:

#### collisions

#### Example:

```
Eth> coll
Transmitted with 1 collisions:0
Transmitted with 2 collisions:0
Transmitted with 3 collisions:0
Transmitted with 4 collisions:0
Transmitted with 5 collisions:0
Transmitted with 6 collisions:0
Transmitted with 7 collisions:0
Transmitted with 8 collisions:0
Transmitted with 9 collisions:0
Transmitted with 10 collisions:0
Transmitted with 11 collisions:0
Transmitted with 12 collisions:0
Transmitted with 13 collisions:0
Transmitted with 14 collisions:0
Transmitted with 15 collisions:0
```

---

## Ethernet Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

Ethernet supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

### GWCON (Talk 5) Activate Interface

Ethernet supports the GWCON (Talk 5) **activate interface** command with no restrictions.

All Ethernet interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

## Configuring Ethernet Network Interfaces

### GWCON (Talk 5) Reset Interface

Ethernet supports the GWCON (Talk 5) **reset interface** command with no restrictions.

All Ethernet interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.

---

## Chapter 23. Overview of LAN Emulation

**Note:** See the glossary for definitions of the acronyms and terms used in this chapter.

The IBM 2216 implements the *LAN Emulation Over ATM: Version 1.0 Specification* which is widely accepted as the industry standard for multivendor multiprotocol interoperability. This chapter introduces basic LAN emulation (LE) concepts in the context of the IBM 2216 implementation. It begins by examining the motivation for installing emulated LANs (ELANs).

---

### LAN Emulation Benefits

LAN emulation protocols allow ATM networks to provide the appearance of Ethernet and Token-Ring LANs. Although LAN emulation does not exploit all of the benefits of ATM, it is useful in migrating to ATM technology and lowering network management costs. It enables you to utilize high-speed ATM links and still protect your software and hardware investments.

Software investments are protected because application interfaces are unchanged (LAN emulation is implemented within the data link control layer, which is below the device driver interface of end stations). Hardware investments are protected with forwarding engines that bridge LAN and ATM networks so that existing adapters and wiring can continue to be used.

LAN emulation allows incremental installation of ATM adapters in stations with high-bandwidth requirements, for example, servers and engineering or multimedia workstations. Physical and logical views of a simple LAN emulation example are illustrated in Figure 15 on page 270.

## Overview of LAN Emulation

### Simple LAN Emulation Network

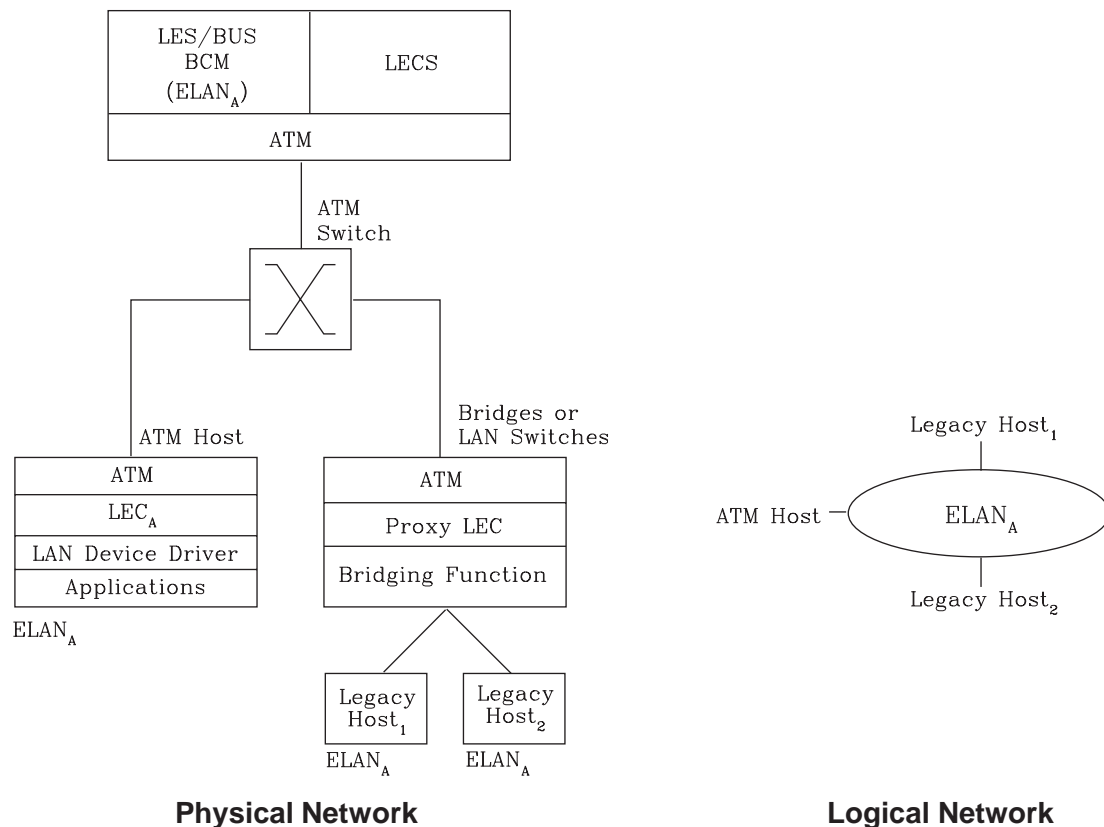


Figure 15. Physical and Logical Views of a Simple LAN Emulation Network

The network management benefits of emulated LANs (ELANs) come from increased flexibility in handling moves, adds, and changes. Membership in an ELAN is not based on physical location; instead, logically-related stations are grouped to form an ELAN (stations can also be members of multiple ELANs).

As long as ELAN memberships are retained, no reconfiguration is needed when stations move to new physical locations. Similarly, no wiring modifications are needed to move stations from one ELAN to another.

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## LAN Emulation Components

The following components implement an ELAN:

### LAN emulation (LE) clients (LECs)

LAN emulation components that represent users of the Emulated LAN.

### LE configuration server (LECS)

A LAN emulation service component that centralizes and disseminates configuration data.

### LE server (LES)

A LAN emulation service component that resolves LAN destinations to ATM addresses.

**Broadcast and Unknown Server (BUS)**

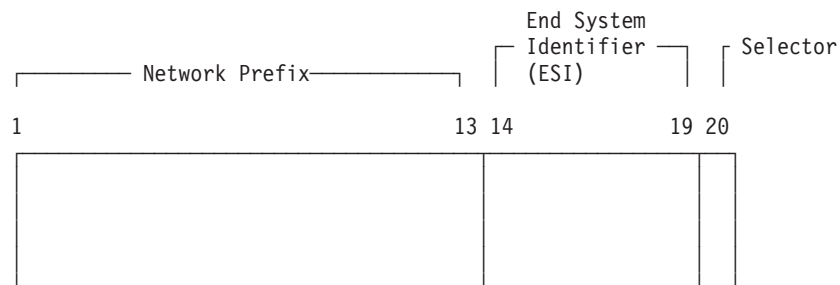
A LAN emulation service component responsible for the delivery of multicast and unknown unicast frames.

The LES, BUS, and LECS are collectively referred to as the LE service components. Each ELAN has a dedicated LES and BUS. LE clients reside in end systems, either in ATM-attached hosts or in bridges or LAN switches. The bridges or LAN switches represent hosts that are connected to Ethernet or Token-Ring LANs. LE clients provide a MAC-level service to higher level software. Either Ethernet IEEE 802.3 or IEEE 802.5 Token-Ring LANs can be emulated, but all stations on an ELAN must be of the same type.

The function that bridges between Token-Ring or Ethernet LAN segments and ELANs is called a Proxy LEC. To emulate a LAN, LE clients request services from the LECS, LES, and BUS. The following sections briefly review ATM addressing and pertinent Interim Local Management Interface (ILMI) functions. You need to understand these concepts before you can understand how the LE components function in the network.

**Addressing in ATM**

ATM uses 20-byte hierarchical addressing:



The first 13 octets of an ATM address are the Network Prefix. Each switch in your ATM network must have a unique Network Prefix. ATM switches use the Network Prefix to route VCC setup requests to the destination ATM switch. End systems, like this router, retrieve their Network Prefix from their ATM switch when they activate.

Octets 14–19 of an ATM address are the End System Identifier (ESI). Each end system attached to the same switch must use a disjoint set of ESIs. When an end system activates, it attempts to register its ESIs with its ATM switch using the Interim Local Management Interface (ILMI).

The ILMI defines a set of SNMP-based procedures used to manage the interface between an end system and an ATM switch. End systems use ILMI to:

- Obtain the network prefix from the switch
- Register their ESIs with the switch
- Dynamically determine the UNI version of the ATM switch
- LECs may get a list of LECS addresses from the switch

The switch forces all of its registered ESIs to be unique.

Octet 20 of an ATM address is the selector.

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End stations obtain their Network Prefix from the switch and form their own addresses by appending an ESI and selector. These addresses must then be registered with the switch, which rejects the registration if the ATM address is not unique.

## ESI

Each ATM interface on the router has a universally administered, or burned-in, MAC address. You can use the MAC address as an ESI for some or all of the router's ATM addresses. Alternatively, you can define up to 64 locally administered ESIs on each interface. If every end system uses its universally administered MAC address as its ESI, then ATM addresses are guaranteed to be unique. This eases the configuration burden. However, using locally administered ESIs can ease problem determination. You can use any combination of universal or locally administered ESIs.

One way to obtain a unique ATM address is to use a burned-in IEEE MAC address as the ESI and to locally choose a unique selector. By default, the router uses the MAC address of the ATM interface as the ESI in its ATM addresses. Additional ESIs can be configured on each ATM interface.

Each ESI can have up to 255 associated selectors (0x00 through 0xff). The range of selectors is partitioned into two subranges, a configured selector range and an automatically assigned selector range. The ATM interface parameter `max-configured-selector` gives the upper bound on the configured selector range.

The ATM components on the router have various ways of choosing a selector. Some components require you to explicitly configure a selector from the configured selector range. LES/BUSs are an example of such a component. Other components, such as Classical IP clients, allow the selector to be automatically assigned at run-time. You do not have to choose the selector because the router does this when it activates. This selector is not guaranteed to be consistent across router restarts. Automatic selector assignment is useful only for those ATM components whose ATM address does not have to be already known by other network devices.

You must configure ATM before you configure emulated LANs, bridging or routing.

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## ATM Addresses of LAN Emulation Components

In general, ATM addresses must be unique among LAN emulation components. The only exception is that a LES and BUS serving the same ELAN can share an ATM address, as is the case on the router.

LAN emulation components are configured for a particular ATM interface. You can decide to use the burned-in MAC address as the ESI portion of the ATM address of the component or you can select one of the locally-administered ESIs that have been defined for the ATM interface. Multiple LE components can share the same ESI if they have unique selectors. By default, the configuration interface assigns each LE component a unique selector value for the configured ESI; however, you can override this assignment and explicitly configure a particular selector value.

An ATM interface parameter determines the number of selectors per ESI reserved for explicit assignment. The remainder are available for dynamic assignment by the ATM interface at run-time. LE components use only the selectors reserved for explicit assignment; by default, 200 of the 256 possible selectors per ESI are

reserved for explicit assignment. Run-time selector assignment is beneficial when you do not need to control the assigned selector, for example, when you are configuring clients in Classical IP that are not paired with an ARP server.

While ATM addresses must be unique among LE components, LE components can use the same ATM addresses as non-LE components, such as Classical IP servers.

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## Overview of Related ILMI Functions

ILMI defines a set of SNMP-based procedures used to manage the user-network interface (UNI) between an ATM end system and an ATM switch. The following three ILMI functions are particularly relevant to LAN emulation:

1. ATM address registration, which is described in “Addressing in ATM” on page 271
2. Dynamic determination of the signaling version being run at the switch
3. Acquisition of the LECS ATM addresses

As mentioned in “Addressing in ATM” on page 271, ATM address registration is a joint effort between ATM end systems and switches. ATM addresses must be registered with the switch before calls can be placed or received.

By default, the ATM interfaces of a router use ILMI procedures to query the switch MIB in an attempt to determine the signaling version (UNI 3.0 or 3.1) being run at the switch. If the query succeeds, the ATM interface runs the same UNI version as the switch; if the query fails, the ATM interface runs UNI 3.0. Alternatively, you can override the default and explicitly configure the UNI version that will run on the ATM interface.

## Manual Configuration of the Signaling Version

You need to configure the signaling version manually if the ATM switch runs UNI 3.1 and has no UNI Version MIB variable. In this case, the ATM interface cannot dynamically determine the UNI version. Because the ATM interface in the router uses UNI 3.0 by default, you should manually configure the ATM interface to use UNI 3.1.

## Locating the LECS Using ILMI

ILMI is the method of choice for locating the LECS. The ILMI MIB at the ATM switch includes a list of LECS ATM addresses that can be retrieved by LE clients. This method is useful because the LECS ATM addresses need only be configured at ATM switches, not at LE clients, and there are fewer switches than LE clients. Clients attempt to connect to the first LECS on this list. If the connection fails, they try the next LECS address in succession until a connection is established.

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## Overview of the LECS Function

LE clients are not required to use the LECS, although it is recommended. If the LECS is not used, each LE client must be configured with the ATM address of the LES that serves its ELAN. The LECS reduces the network management burden by serving as a centralized repository for configuration data, minimizing configuration of the LE clients.

**Note:** At most, one LECS is configurable on each router.

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Clients connect to the LECS using well-defined procedures. The following steps are attempted by a client, in order, until a virtual channel connection (VCC) to the LECS is established:

1. Connect to the LECS using any configured LECS address information (configuration of an LECS ATM address at LE clients is optional and is **not** recommended).
2. Obtain a list of LECS addresses using ILMI and attempt to connect to each LECS on the list, in order, until a VCC is established.
3. Establish a VCC to the well-known LECS ATM address as defined by the ATM Forum.

As previously stated, ILMI is the preferred method for LE clients to locate the LECS. The well-known LECS address is needed because some switches do not support the ILMI method. Configuring the LECS address at the LE clients should be done **only** when the switch does not support the ILMI method and the LE service does not support the well-known LECS address.

The router and the IBM ATM switch support all three methods: the pre-configured LECS address, ILMI connection, and the well-known LECS ATM address.

The LECS must provide initial configuration data to LE clients. The most crucial piece of data is the ATM address of the LES. To provide this information to an LE client, the LECS must be able to identify the LE client and to determine the correct LES for that LE client. The LECS identifies an LE client using information in the LE\_CONFIGURATION\_REQUEST frame sent by the LE client. The configuration request can also contain information to identify the ELAN that the LE client is seeking to join. The following information can be included in the configuration request:

1. Primary ATM address of the LE client  
This field is required and uniquely identifies the LE client.
2. LAN destination associated with the LE client  
This field can contain a MAC address or a route descriptor that uniquely identifies the LE client or it can be unspecified.
3. ELAN Name  
This field can contain a name identifying the requested ELAN or the requesting LE client. In the router implementation, ELAN names are standard ASCII strings. The ELAN name can be unspecified in the request.
4. ELAN Type  
This field can specify that the LE client belongs to an Ethernet or Token-Ring ELAN, or it can be unspecified. If the LE client specifies the type of ELAN, the LECS cannot assign the client to an ELAN of a different type.
5. Maximum frame size supported by the LE client  
This field can specify the upper bound on the size of a data frame that can be processed by the LE client, or it can be unspecified. The LECS cannot assign a client to an ELAN with a maximum frame size **larger** than that specified by the client. If the ELAN allows frames too large for the client to handle, the client cannot function on that ELAN.

Given this information, the LECS assigns the LE client to a LES. This is accomplished through the use of policies and policy values. A policy is a criterion that the LECS uses to make LE client-to-LES assignment decisions. A policy value is a (value, LES) pair that indicates that the specified value should be assigned to the specified LES. For example, a policy could be the MAC address of the LE



client, and a policy value could be (MAC ADDR\_A, LES\_1). An LE client with MAC ADDR\_A will be assigned to LES\_1 if the LE client has not already been assigned to another LES because of a higher-priority policy. One set of policies and policy values applies to all the ELANs.

In accordance with the LE service MIB Specification of the ATM forum, these are the six policies defined:

1. ATM address
2. MAC address
3. Route descriptor
4. ELAN type
5. Max frame size
6. ELAN name

Policies also have priorities. The LECS examines policies in prioritized order. Policies with smaller values in the priority field are considered before policies with larger values in the priority field. Policies with equal values in the priority field are considered at the same time and *ANDed* together.

The LECS assigns an LE client to a LES when all of the policies at the current priority level are satisfied and in agreement. The policies are satisfied when there is a policy value that matches the corresponding field in the configuration request for each policy at the current level. The policies are in agreement when the set of matches include a LES that is common to all the policies. If these conditions are not met, the LECS considers the policies at the next priority level. If the LECS is unable to find a LES at any priority level, an unsuccessful configuration response is returned to the LE client.

To understand the meaning of agreement of the policies, consider this example of policies not in agreement. Suppose that the policies at priority 1 are a MAC address and an ELAN name. One of the policy values is (X'400000121225', LES\_A) and one is (ELAN 1, LES\_B). If the LE client provides a LAN destination of X'400000121225', the MAC address policy is satisfied. If the LE client provides an ELAN name of *ELAN 1*, then the ELAN name policy is also satisfied. In this case the policies at priority 1 are *not* in agreement because they refer to different LESs. In this example, the LECS would examine the policies at the next priority level.

After determining the correct LES for an LE client, the LECS returns a configuration response to the LE client that includes the following information: LES ATM address, ELAN type, max frame size, and ELAN name. The configuration response can also include type/length/value (TLV) parameters. TLVs provide a method to download optional or user-defined parameters to the LE client.

## Sample Situations for Use of the LECS Assignment Policies

The following section offers examples of various LECS assignment policies.

### ATM Address Policy

The LECS permits two types of ATM address policy values. The first type is a variable length ATM address prefix. For example, the policy value (399999999999900000102, LES\_A) means that all LE clients whose ATM address begins with 399999999999900000102 should be assigned to LES\_A.

The second type of ATM address policy value is an ESI and Selector of an ATM address. For example, the policy value (10002345003281, LES\_A) means that the LE client with an ESI of 100023450032 and a selector of 81 should be assigned to LES A.

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When given the ATM address of an LE client, the LECS searches first for a matching ESI and selector. If no match is returned, the LECS searches for the ATM address prefix policy value with the longest matching prefix. Thus, for example, the above policy value (399999999999990000, LES\_B).

ATM address ESI and selector policy values can be used to assign clients to LESs in a manner independent of the LE clients physical location (the ESI and selector is defined locally to the client). ATM address prefixes are the only policy values which indicate any geographic information.

### LAN Destination Policy

LE clients can be assigned to LESs based upon a MAC address or a route descriptor. Because a LAN destination uniquely identifies an LE client in a manner that is independent of geographic location, this policy is useful in ensuring that the LE client is assigned to the correct ELAN regardless of its physical location, for example, retaining the ELAN memberships of a workstation when it is moved from one switch to another.

### ELAN Name Policy

ELAN names are perhaps the most flexible of the assignment criteria. Some of the ways that ELAN name policy values can be used are:

- Use the actual name of the ELAN

If LES\_A serves Elan 1, then create the policy value (Elan 1, LES\_A). LE clients specifying Elan 1 in configuration requests will then be assigned to LES\_A.

- Use aliases for the ELAN

For example, all LE clients belonging to members of the Accounting Department could be configured to use the ELAN name *Accounting*, while those belonging to the Engineering Department could use the ELAN name *Engineering*. Depending upon the number of LE clients on the ELANs, these names could be directed to the same ELAN by configuring these policy values:

```
(Accounting, LES_A)
(Engineering, LES_A)
```

or to different ELANs by configuring these policy values:

```
(Accounting, LES_A)
(Engineering, LES_B)
```

This setup requires configuring the LE clients with the correct ELAN Name.

- Use names for the LE clients

Each LE client can be given its own name. For example, you could create the policy values (Joe, LES\_A) and (Mary, LES\_A). Then, the LE clients configured with these names would be directed to the same LES. This method requires configuring the ELAN name at each LE client and at the LECS. However, it allows Joe and Mary to move the client to a new location. Even though moving causes the client to have a new ATM address or MAC address, as long as you configure the new LE client with the same ELAN name, you retain membership in the original ELAN. This technique also offers a moderate amount of security if the names of each LE client are considered to be passwords.

### ELAN Type Policy

ELAN type policy values are most useful for providing default ELANs. For example, the following policy values would ensure that every LE client is assigned to one of the LESs:

(Token-ring ELAN Type, LES\_A)  
 (Ethernet ELAN Type, LES\_B)  
 (Unspecified ELAN Type, LES\_C)

In general, policies used for providing default ELAN assignments should be given a low priority, so that the more specific policies are considered first.

### Max Frame Size Policy

The max frame size policy can also be used to provide default ELAN assignments.

### Duplicate Policy Values

Duplicates occur when the same policy value is associated with multiple LESs for a given policy. Duplicate policy values are allowed for the ELAN type and max frame size policies, but are not allowed for other policies. Duplicate values are useful only when combined with a different policy of the same priority.

For example, assume that there are three ELANs: an Ethernet ELAN with a max frame size of 4544 bytes, a Token-Ring ELAN with a max frame size of 4544 bytes, and another Token-Ring ELAN with a max frame size of 18190 bytes. LE clients could be assigned to the appropriate ELAN by setting the ELAN type and max frame size policies to the same priority level and defining the following policy values:

(Ethernet ELAN Type,	LES_1)	(Max Frame Size = 4544,	LES_1)
(Token-Ring ELAN Type,	LES_2)	(Max Frame Size = 4544,	LES_2)
(Token-Ring ELAN Type,	LES_2)	(Max Frame Size = 18190,	LES_2)

## More Information About TLVs

TLVs are defined on an ELAN basis; therefore, the same set of TLVs is returned to all LE clients that are assigned to a particular ELAN. When a TLV is included in a configuration response, the LE client *must* use the value specified in the TLV as an operating parameter (if the LE client recognizes the ELAN type). A few examples of situations where TLVs might be beneficial are as follows:

- When ELANs are spread over large geographic locations, the default timeout values for LE clients may be insufficient. These timeouts can be controlled for all LE clients by specifying their value in a TLV at the LECS.
- By default, ELANs use best-effort connections to connect to the BUS. For ELANs where BUS traffic is heavy, better performance can be obtained by using reserved bandwidth connections to the BUS. The characteristics of the Multicast Send VCC between the LE client and the BUS can be controlled with TLVs.
- A TLV can be used to download the ELAN segment number to source route bridges.

In addition to fine-tuning the configuration, TLVs force all clients on the ELAN to operate with consistent parameters. The IBM 2216 supports all ATM Forum-defined TLVs along with arbitrary, user-defined TLVs.

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## Connecting to the LES

After obtaining the ATM address of the LES, the LE client initiates a Control Direct VCC to the LES. When this VCC has been established, the LE client sends an LE\_JOIN\_REQUEST to the LES. The LES responds by adding the LE client to the appropriate point-to-multipoint Control Distribute VCC and returning an LE\_JOIN\_RESPONSE. By default, the LES partitions proxy and non-proxy clients onto separate Control Distribute VCCs as illustrated in Figure 16 on page 278; however, you can configure the LES to use a single Control Distribute VCC for all LE clients in order to reduce the number of point-to-multipoint VCCs that are

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required. Partitioning the VCCs is generally useful because it reduces the amount of nuisance traffic that is sent to non-proxy clients. No LE\_ARP\_REQUESTs are sent to non-proxy LE clients, as described in “Address Resolution”.

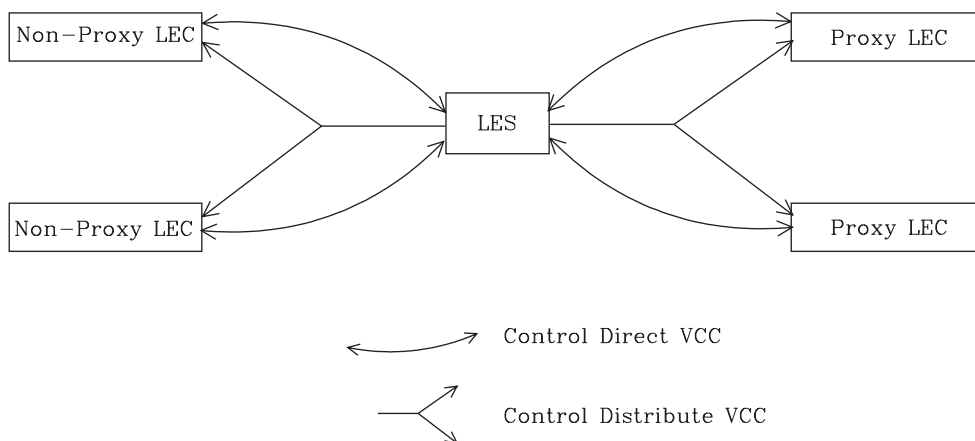


Figure 16. Default Connections Between LE Clients and the LES

The following ATM connections are established between the LE client and the LES:

**Control Direct VCC (bidirectional point-to-point)**

From LE client to LES

**Control Distribute VCC (point-to-multipoint)**

From LES to LE client

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## Address Registration

LE clients register LAN destinations with the LES to ensure uniqueness and to allow the LES to answer LE\_ARP\_REQUESTs, which LE clients issue to learn the ATM address associated with a particular LAN destination. Registrations include the LAN destination and the ATM address that the LE client associates with the LAN destination. A LAN destination can be either a MAC address or a route descriptor.

Proxy LE clients do not register the MAC addresses of stations on LAN segments that they are bridging to the ELAN. On the other hand, non-proxy LE clients must register all the LAN destinations that they represent. All route descriptors must be registered, regardless of whether they are associated with a proxy or a non-proxy LE client. Route descriptors are applicable only to proxy LECs that are performing source route bridging. A route descriptor contains the bridge number of the proxy LE client and the segment number of a ring that the LE client is bridging to that is equivalent to one hop away.

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## Address Resolution

LAN communications are based upon source and destination MAC addresses. To enable such communication on an ATM network, MAC addresses must be resolved to ATM addresses. An LE client sends an LE\_ARP\_REQUEST to the LES to learn the ATM address of a particular LAN destination. If the LAN destination is registered, the LES responds with the ATM address associated with the LAN destination. Otherwise, the request is forwarded to all proxy LE clients on the Control Distribute VCC. There is no need to forward the request to non-proxy LECs because all of their LAN destinations are registered; however, if the LES is configured to use a single Control Distribute VCC, both proxy and non-proxy LE

clients will receive the request. Control Distribute VCCs provide an efficient way for the LES to distribute control frames to multiple LE clients.

Proxy LE clients respond to LE\_ARP\_REQUESTs for unregistered MAC addresses that they represent. The LE\_ARP\_RESPONSE is sent to the LES on the Control Direct VCC, and the LES forwards the response to the LE client that issued the request.

## Connecting to the BUS

After connecting to the LES, an LE client issues an LE\_ARP\_REQUEST for the all 1s broadcast MAC address. The LES responds with the ATM address of the BUS. The LE client then initiates the establishment of a Multicast Send VCC to the BUS. The BUS responds by adding the LE client to the appropriate point-to-multipoint Multicast Forward VCC. By default, the BUS partitions proxy and non-proxy clients onto separate Multicast Forward VCCs; however, as was the case with the Control Distribute VCC, you can configure the BUS to use a single Multicast Forward VCC for all LE clients. Figure 17 shows partitioned Multicast Forward VCCs.

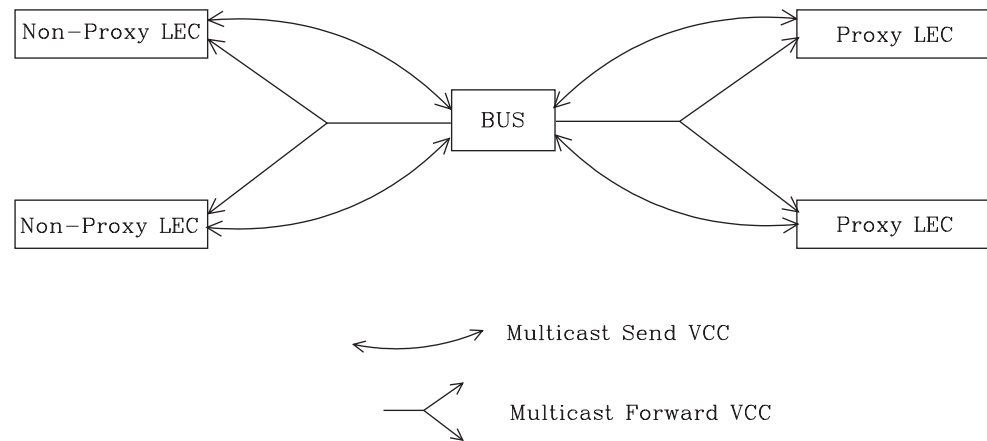


Figure 17. Default Connection Between LE Clients (LECs) and BUS

This list is provided to help you clarify the ATM connections that are established between the LE client and the BUS:

**Multicast Send VCC (bidirectional point-to-point)**

From LE client to BUS

**Multicast Forward VCC (point-to-multipoint)**

From BUS to LE client

## BUS Functions

The BUS has two basic functions:

1. Distribute multicast frames to all the LE clients in the ELAN
2. Forward unicast frames to the appropriate destinations

An LE client sends unicast frames to the BUS if it does not have a direct connection to the LE client that represents the destination. To avoid creating a bottleneck at the BUS, the rate at which an LE client can send unicast frames to the BUS is limited.

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In the router implementation, the BUS has two modes of operation: partitioning the unicast frame domain and not partitioning the unicast frame domain. If you partition the unicast frame domain, the BUS uses two Multicast Forward VCCs. Otherwise, the BUS uses a single Multicast Forward VCC.

If a single Multicast Forward VCC is used, the BUS operation is very simple; all received frames are simply forwarded to all LE clients. If two Multicast Forward VCCs are used, the BUS will not broadcast unicast frames to all LE clients; instead, unicast frames destined for non-proxy LE clients will be transmitted directly to the destination LE client on a Multicast Send VCC, and all other unicast frames will be transmitted only to proxy LE clients, using the Proxy Multicast Forward VCC. When two multicast VCCs are used, the router is considered to be in intelligent BUS (IBUS) mode.

IBUS mode reduces nuisance unicast frames, which are unicast frames not destined for the client; proxy clients do not receive unicast frames destined for non-proxy clients, and non-proxy clients never receive nuisance unicast frames. Network bandwidth devoted to nuisance frames is also reduced. On the other hand, BUS processing requirements are increased and multicast frames must be transmitted twice (once on each Multicast Forward VCC). In general, IBUS operation is recommended; however, this option should be disabled in configurations that have source route bridges that join the ELAN as non-proxies.

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## Establishing Data Direct VCCs

Data Direct VCCs connect two LE clients, and are used to exchange unicast frames without involving the BUS. The LE client uses the address resolution procedures to determine the ATM address associated with the required LAN destination. If the LE client already has a Data Direct VCC to the ATM address (perhaps for another LAN destination represented by the target LE client), unicast data frames are subsequently transmitted on the existing VCC; otherwise, the LE client invokes the signaling protocol to establish a new VCC.

The LE client maintains an LE\_ARP cache containing LAN destination-to-ATM address mappings. Entries in this cache are aged and must be periodically refreshed. The entries are refreshed when a data frame is received from the LAN destination. The LE client also attempts to refresh entries in the absence of data traffic.

Utilization of Data Direct VCCs is also monitored and the VCCs are released if there is no traffic for the VCC time-out period, which is configurable. Additionally, Data Direct VCCs are released in a least-recently used manner when establishment of a new Data Direct VCC fails due to insufficient resource availability.

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## Overview of Extensions for LAN Emulation

IBM has made value-add extensions to ATM Forum LAN Emulation available on the router. These extensions offer improved performance, reliability, security, and manageability:

### **Broadcast Manager (BCM)**

This function can improve overall network performance by reducing ELAN broadcasts.

### **Redundancy**

The redundancy mechanism improves reliability by allowing backup servers to take over if failures occur at primary servers.



### Security

Security is improved by letting the LECS control ELAN memberships.

### BUS Monitor

This function enhances manageability by identifying the top users of the BUS.

The following sections describe each of these extensions.

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## Broadcast Manager

Broadcast Manager (BCM) is an extension to LAN emulation that consists of IBM enhancement of the LAN emulation BUS. Without BCM, the following events occur:

- A multicast frame sent to the BUS is forwarded to all LE clients on the ELAN.
- LE clients that include the proxy function to provide bridging support forward the broadcast frame on to other LAN segments.
- All end stations receive and process every broadcast frame.

BCM can be enabled on individual ELANs for any of these protocols:

- IP
- IPX
- NetBIOS

When BCM is enabled, a minimal amount of Layer 2 and Layer 3 information is decoded for specific types of broadcast frames sent to the BUS. Whenever possible, BCM transforms broadcast frames into unicast frames, and sends them only to interested LE clients and end stations. BCM reduces both network traffic and associated end-station overhead by filtering nuisance broadcast frames. These functions can improve overall system performance and enable practical deployment of larger ELANs.

## BCM Support for IP

When enabled for IP, BCM scans all IP ARP requests and replies to learn the location of IP addresses in the IP subnet that contains this ELAN. The objective is for BCM to take each broadcast ARP request frame and forward it as a unicast frame directly to the LE client representing the target IP station. Both network traffic and end-station processing time are reduced when the request is forwarded directly to the appropriate LE client on the Multicast Send VCC instead of being broadcast to all LE clients on the Multicast Forward VCCs. When the destination station is located behind a bridge function, the LAN that the destination station belongs to also benefits from the reduced broadcast traffic.

## BCM Support for IPX

For IPX, BCM limits the scope of advertisements and other broadcast requests. IPX routers and servers periodically broadcast their known network and service information. IPX clients send broadcast requests to locate a particular service or router. Generally, these broadcasts, called Routing Information Protocol (RIP) and Service Advertising Protocol (SAP) packets, need to be received only by other IPX routers and servers.

When it is enabled for IPX, BCM dynamically identifies the set of IPX routers and servers based on advertisement transmissions, and only forwards RIP and SAP advertisements and other broadcast requests to other IPX routers and servers. A broadcast frame managed by BCM IPX is sent as a series of unicast frames to the dynamically-learned set of IPX routers and servers.

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When BCM IPX Server Farm Detection is enabled, BCM IPX will detect an IPX server farm when the number of IPX routers and servers discovered behind a given LEC exceeds a configurable threshold, the *BCM IPX Server Farm Threshold*. When a server farm is detected, BCM IPX broadcasts a managed frame to each LEC representing a server farm, rather than transmitting multiple unicast frames to each downstream IPX router and server in the server farm. BCM IPX can now intelligently use the broadcast mechanism in areas of the network where it is desirable to do so.

With BCM IPX enabled, any quiet device (that is, a device that does not transmit IPX advertisements) that needs to receive IPX advertisements has to be configured as a BCM static target. An example of such a device is a station running software that discovers the IPX network topology by monitoring IPX advertisements.

If BCM IPX Server Farm detection is enabled and you wish to prevent a particular LEC from being treated by BCM IPX as a Server Farm, configure a BCM static target with the LEC's ATM address and a MAC address of 00.00.00.00.00.00. This forces BCM IPX to send frames managed by BCM as multiple unicast frames to each downstream IPX router and server detected behind this LEC, even if the number of routers and servers detected exceeds the *BCM IPX Server Farm Threshold*.

## BCM Support for NetBIOS

NetBIOS is considered to be a broadcast-abusive protocol and therefore an excellent candidate for BCM. NetBIOS communication is based on names. Transmitting stations can learn the MAC address associated with a particular destination name by broadcasting a query or by having the frame multicasted to the NetBIOS functional address. In the latter case, every NetBIOS device in the network must receive the frame and determine whether the destination name on the frame applies to itself. To make things even worse, NetBIOS devices tend to repeat transmission of certain types of frames as much as 10 times. Historically, this was to ensure that all devices receive the frame in cases where the network is heavily congested.

The BCM strategy is to associate unique NetBIOS names with MAC addresses and LE clients by learning names from NetBIOS frames sent to the BUS. After a unique NetBIOS name is learned, subsequent NetBIOS broadcast frames destined for that name are forwarded to a single LE client as a unicast frame. BCM also filters certain NetBIOS frames that are broadcast repeatedly.

BCM provides support for NetBIOS Namesharing. That is, BCM NetBIOS handles OS/2 LANServer stations with multiple LAN adapters sharing the same NetBIOS name.

## BCM Support for Source Route Bridging

Source Route Management (SRM) is an additional BCM feature that can be configured for 802.5 ELANs. When enabled, this feature will further process frames managed by BCM IP or BCM NetBIOS and, whenever possible, transform All Routes Explorer (ARE) or Spanning Tree Explorer (STE) frames into Specifically Routed Frames (SRF). Once a frame is transformed into an SRF, the frame no longer needs to be transmitted onto each ring in the bridged network.

The Token-Ring topology behind each LE client is learned by recording the routing information field (RIF) of frames received by the BUS. Because SRM dynamically



learns Token-Ring topology information, an aging mechanism is used to remove information that has not been refreshed recently.

To decide whether to enable BCM or SRM (or both), you should compare the net system-wide benefit with the inevitable reduction in the rate at which packets are forwarded when BCM or SRM is enabled.

**Note:** Broadcast Manager and Source Route Management are unavailable and cannot be enabled if **bus-mode** is set to *adapter* or *vcc-splice*.

## LAN Emulation Reliability

A perceived lack of robustness has been one of the most widely proclaimed criticisms of LAN emulation. While the ATM Forum is addressing this issue with specifications for distributing the LE service, the router offers an answer in the interim. Figure 18 provides a framework for describing the MSS redundancy solution.

Each LES/BUS may be independently configured for redundancy (the default is no

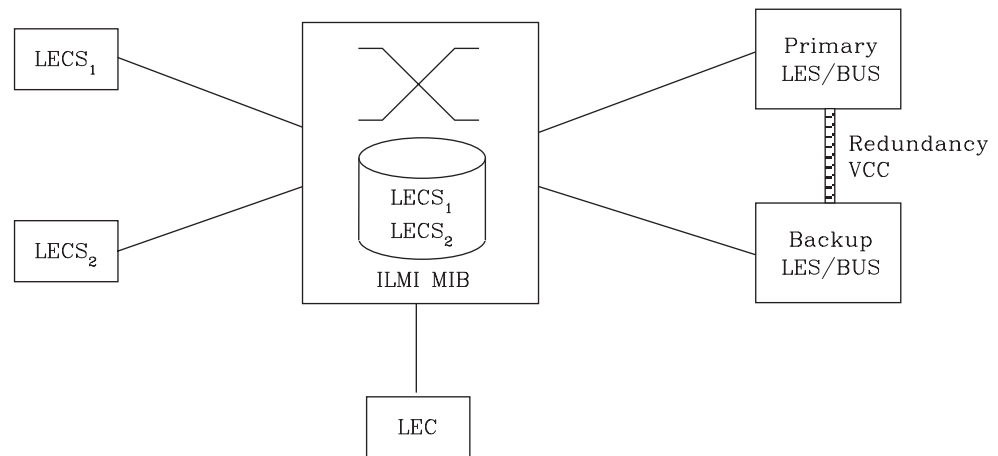


Figure 18. LAN Emulation Redundancy

redundancy). If redundancy is enabled, the LES/BUS is configured to assume the role of a primary or a backup LES/BUS. Unless it has been configured as a redundant LES/BUS, the LES/BUS is primary. The primary LES/BUS is typically the only LES/BUS visible to the LE clients. It is responsible for setting up and maintaining an Enhanced Redundancy VCC to the backup LES. The presence of this VCC and timely status messages indicate that the primary LES/BUS is operational.

If the Enhanced Redundancy VCC is **not** present, the backup LES/BUS services ELAN requests in the usual manner. If the backup LES/BUS is servicing the ELAN when the Enhanced Redundancy VCC is established by the primary, the behavior is determined by the setting of LES/BUS Peer Redundancy Support.

Enabling Peer Redundancy support allows clients to remain active on the backup LES/BUS even after the Enhanced Redundancy VCC is established between the primary and backup LES/BUS. When Redundancy support is enabled, but Peer Redundancy is disabled, the backup terminates all its clients when the Enhanced Redundancy VCC is established, always yielding to the primary LES/BUS. When Redundancy and Peer Redundancy support are both enabled and the Enhanced Redundancy VCC is up, the primary and backup LES/BUS periodically transmit

## Overview of LAN Emulation

status messages to one another containing the number of active clients. In the event that the primary and backup LES/BUS each has active clients at the time when the Enhanced Redundancy VCC is established, the LES/BUS with the lower number of active clients terminates its clients, yielding to the LES/BUS with the higher number of active clients. If the number of active clients is equal, the backup LES/BUS yields to the primary. In order to give preference to the primary LES/BUS in the race condition where primary and backup become operational at approximately the same time, the backup will yield to the primary if the Enhanced Redundancy VCC is established within one minute of the backup registering itself with the ATM switch.

For simplicity, only the Primary LES/BUS has the Peer Redundancy option. Peer Redundancy is disabled by default to maintain the redundancy behavior of prior releases of router software.

For the redundancy protocol to be effective, LE clients must detect the failure of the primary LES/BUS and connect to the backup. LE clients detect server failures by means of released VCCs. Connection to the backup LES/BUS is accomplished through the LECS.

Upon receiving an LE\_CONFIGURE\_REQUEST, the LECS assigns the LE client to the appropriate LES and ELAN. If this LES has no configured backup, then the LECS returns the ATM address of the LES. If the LES is configured with a backup LES, then the LECS returns either the primary or backup LES address.

The LECS returns the backup LES address if the backup LES exists on the same MSS Server as the LECS and is currently serving the ELAN, if the primary LES exists on the same MSS Server as the LECS and it is not currently serving the ELAN, or if neither LES exists on the same MSS Server as the LECS and the client was last assigned to the primary LES (within the past 5 minutes). Otherwise, it returns the primary LES address to the LE client.

The LECS retains a short-term memory of all client assignments so that it can alternately direct an LE client to a primary and backup LES. This simple heuristic makes the correct assignment in the nominal case of no failure and is self-correcting. At worst, the heuristic causes the LE client to repeat the configuration phase of joining an ELAN.

LECS robustness can be achieved by establishing duplicate LECSs on multiple platforms and including their ATM addresses in the ILMI database. LE clients will then connect to the backup LECS if the primary is unavailable. could be on MSS Server 1, while

---

## LAN Emulation Security

Traditional LANs offer security in the sense that a physical connection implies that two stations are on the same LAN. Because multiple emulated LANs can exist on a single ATM network, stations that are not on the ELAN can be physically connected to stations that are on the ELAN. This situation presents a security risk in that unauthorized stations can connect to the LES and attempt to use its services.

To control ELAN membership, an MSS LES can be configured to validate LE\_JOIN\_REQUESTs with the LECS. In this mode the LES forms an LE\_CONFIGURE\_REQUEST on behalf of the LE client using information from the LE\_JOIN\_REQUEST. These LE\_CONFIGURE\_REQUESTs include the source LAN destination, source ATM address, ELAN type, max frame size, and ELAN name

from the LE\_JOIN\_REQUEST, along with an IBM Security TLV. The security requests are transmitted to the LECS by a multiplexing component called the LECS interface, and the LECS must validate the requests using its ELAN assignment database before LE clients are allowed to join the ELAN.

A LECS interface is associated with an ATM interface, and all LESs configured on the ATM interface use the same LECS interface. The LECS interface conserves VCC resources by multiplexing security requests from multiple LESs onto a single VCC to the LECS. The LECS interface locates the LECS dynamically using the ILMI and well-known LECS address mechanisms. After the VCC to the LECS is established, the LECS interface issues a local query to determine whether the LECS is located on the same router. If the LECS is located on the same router, a local interface is used to confirm requests to join without transmitting requests onto the ATM network.

With the LECS interface, the router may ensure that an LE Client joins an ELAN only if the LECS approves of the join. This shifts the security burden from the LES to the LECS. Unfortunately, the LECS is also non-secure. The LECS accepts connections and queries from any station without verification. An intruder station may connect to the LECS and repeatedly query it for various configurations. The intruder may also pose as some other station and download another station's configuration.

LECS Access Controls permit the user to configure a list of ATM address prefixes which are not allowed access to the LECS configuration database. All LECS connection attempts and LE\_CONFIGURE\_REQUESTs from matching ATM addresses are automatically rejected. When used in conjunction with the LECS interface, a secure LANE environment is provided.

To maximize the security of an ELAN, the following steps are recommended:

1. At the LECS, use ATM addresses to assign clients to the LES. See "Overview of the LECS Function" on page 273 for more information.
2. Activate the LECS Interface on the router.
3. Activate the security option of the LESs.
4. Activate LECS Access Controls for any ATM address prefixes that should not be allowed to access the LECS.
5. Use *Address Screening* at the ATM switches. This option causes switches to validate that calling stations use their actual ATM addresses in the call setup. Thus, stations cannot impersonate other stations.

These steps ensure that stations are correctly identified and that only authorized stations join the ELAN.

---

## LAN Emulation Network to Network Interface (LNNI)

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### Key Configuration Parameters for LAN Emulation

This section briefly describes the required configuration parameters of the router LAN emulation components. The ATM interface for the LAN emulation components must be defined before the components can be created.

1. **LEC:**

To create an LE client, you only need to specify the ELAN type. If you define two LE clients on a single ATM interface and bridge them together, then one of

## Overview of LAN Emulation

the LE clients must use a non-default MAC address. By default, LE clients use the burned-in MAC address of the ATM interface. The default maximum frame size is 1516 bytes for Ethernet LE clients and 4544 bytes for token-ring LE clients.

---

## Chapter 24. Using ATM

This chapter describes how to use the ATM interface. It includes the following sections:

- “ATM and LAN Emulation”
- “How to Enter Addresses”
- “ATM-LLC Multiplexing” on page 288
- “ATM Virtual Interface Concepts” on page 288

---

### ATM and LAN Emulation

LAN emulation provides support for virtual Token-Ring and Ethernet LANs over an ATM network. Refer to “How to Enter Addresses” for a discussion of ATM addressing.

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### How to Enter Addresses

Enter addresses in two ways, depending upon whether the address represents (1) an IP address, or (2) an ATM address, MAC address, or route descriptor, or MAC address, as follows:

1. IP address

Enter IP addresses in dotted decimal format, a 4-byte field represented by four decimal numbers (0 to 255) separated by periods (.).

**Example of IP Address:**

01.255.01.00

2. ATM or MAC address or route descriptor

Enter ATM addresses, MAC addresses, and route descriptors as strings of hexadecimal characters with or without optional separator characters between bytes. Valid separator characters are dashes (-), periods (.), or colons (:).

Examples of ATM address, MAC address or route descriptor

A1FF01020304

or

A1-FF-01-02-03-04

or

A1.FF.01.02.03.04

or

39.84.0F.00.00.00.00.00.00.00.00.00.03.10.00.5A.00.DE.AD.08

or

A1:FF:01:02:03:04

or even

A1-FF.01:0203:04

Each type of address requires a different number of hexadecimal characters:

**ATM** 40

**MAC** 12

**ESI** 12

**Route descriptor**

4

This information applies to addresses entered for ATM, LAN emulation, Classical IP and ARP over ATM, IPX over ATM, and ARP over ATM.

### ATM-LLC Multiplexing

Protocols that run natively over an ATM interface can use ATM-LLC multiplexing to share ATM addresses and both SVC and PVC channels between users. ATM-LLC is implicitly configured when the protocols are configured and can be monitored using the `ATM Config+` command prompt from **t 5**. There are no explicit configuration options for the ATM-LLC multiplexing function. For example, if two protocols which use ATM-LLC multiplexing are configured to use the same local ATM address (local endpoint), this implicitly configures ATM-LLC to use the same shared ATM address for both protocols.

See “ATM-LLC Monitoring Commands” on page 303 for additional information.

Sharing of ATM addresses or SVC/PVC channels is not possible between protocols that use the ATM-LLC multiplexing function and those that do not use the ATM-LLC multiplexing function (such as Classical IP). Currently, Server Cache Synchronization Protocol (SCSP) and APPN are the only two protocols that use the ATM-LLC multiplexing function.

---

### ATM Virtual Interface Concepts

An ATM Virtual Interface (AVI) creates the appearance of multiple ATM interfaces when, in fact, there is only one physical ATM interface. One or more AVIs can be configured for each physical ATM interface on the device. AVIs have the following characteristics:

- Each AVI must be defined on one (and only one) physical ATM interface. ATM real interface (ARI) will be used to mean a physical ATM interface.
- One or more AVIs can be configured on each ARI on a device.
- Higher layer protocols treat ARIs and AVIs equally. The protocols see the total number of ATM interfaces as the sum of the number of ARIs and AVIs configured on the device.
- Protocols can be configured on each ATM interface (real or virtual) independently of other interfaces.

For example, one can configure IP on interface 0 (which is a real ATM interface) with IP address 9.1.1.1 and another instance of IP with address 9.2.1.1 on interface 1 (which is an AVI). Whether an interface is a real ATM interface or a virtual interface configured on a real interface makes no difference to the protocol (IP in the example). In addition, whether virtual interface 1 is configured on top of real ATM interface 0 or some other physical ATM interface is also transparent to the protocols.

### Advantages of Using ATM Virtual Interfaces

Major advantages of using the ATM Virtual Interfaces are:

- Using the ATM Virtual Interface feature increases the number of protocol instances that can be supported on a physical ATM interface.

The actual number of AVIs that can be configured on an ARI is limited by physical resources, such as memory, available on the device. The total number of interfaces that can be created depends on the data packet size for the interfaces and is limited to a maximum number of 253 per device.

The use of AVIs significantly improves the configuration options for protocols such as IPX that are limited to one instance or address per ATM interface. By configuring an appropriate number of AVIs, several IPX addresses can be supported on each physical ATM interface.

## ATM Virtual Interface Configuration Concepts

- The ATM Virtual Interface feature is crucial for supporting multicast routing protocols (such as MOSPF) over ATM networks.

In order for multicast to operate correctly, each logical subnet *must* be configured on a different interface because multicast routing protocols typically function in such a way that a packet coming in from a device interface will never be sent out over the same interface. Thus, if more than one subnet is configured on an interface and a source in one subnet sends a multicast packet to a member in another subnet defined on the same interface, this member will never receive the packet.

By creating an individual virtual interface for each subnet, packet multicasting can be performed successfully. Typically, the number of ATM interfaces on a device will be limited, in turn limiting the number of subnets that can be correctly configured for multicast operation. However, by creating as many AVIs as needed (according to the number of subnets that are required to be configured on the device), the number of physical ATM interfaces will no longer limit the number of subnets that can be configured on a device for correct multicast operation.

For example, the “one-armed” router cannot support multicast traffic over interfaces other than ELANs without the AVI feature, because incoming packets will never be sent out the same interface and will be discarded instead.

- Creating multiple AVIs on an ARI and configuring each different protocol instance (for example, each IP subnet) on a different AVI on the same ARI, can improve performance.

For example, when multiple subnets are configured on a single physical ATM interface, the interface will have to reduce the maximum transmission unit or MTU (the maximum packet size that can be sent or received over that interface) to the smallest MTU of all subnets sharing the same interface. However, if multiple AVIs are created on that ARI and each IP subnet is configured on a different AVI, every subnet can continue to use its existing MTU size without consideration of other subnets configured on the same physical ATM interface. This avoids possible reduction in throughput and delays due to packet fragmentation and reassembly caused by MTU size reduction.

Another performance improvement can be achieved by distributing the number of protocol addresses configured on a physical interface over different virtual interfaces configured on the same physical interface. The per-interface protocol lists get shortened, resulting in faster searches and reduced processing time.

## Disadvantages of using ATM Virtual Interfaces

The disadvantages of using ATM Virtual Interfaces are:

- Because AVIs do not have any physical resources of their own, each virtual interface may have fewer Virtual Connections (VCs) than a single physical interface. The available resources (in this example VCs) are partitioned among the different virtual interfaces configured on a single ARI and the ARI itself.

In the current implementation, resource allocation is *on demand*. Each physical ATM interface has a pool of resources that are available for use by all AVIs and the single ARI itself.

**Note:** Because all resources are shared among the ARI and all its AVIs, an ESI added on an ARI is automatically available to all AVIs configured on the ARI. You should not assign the same ESI and selector combination to two different protocol clients using the same ARI even though they are configured on different AVIs.

## **ATM Virtual Interface Configuration Concepts**

Limited PVC sharing is allowed across the ARI and the AVIs configured on the ARI. PVC sharing is limited to different protocol instances. Multiple instances of the same protocol are not allowed to share the same PVC.



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## Chapter 25. Configuring and Monitoring ATM

This chapter describe the ATM interface configuration and operational commands. It includes the following sections:

- “Accessing the ATM Interface Configuration Process”
- “ATM Configuration Commands”
- “ATM Interface Configuration Commands” on page 292
- “ATM Virtual Interface Configuration Commands” on page 298
- “ATM Virtual Interface Monitoring Commands” on page 303
- “Accessing the ATM Monitoring Process” on page 299
- “ATM Monitoring Commands” on page 299
- “ATM Interface Monitoring Commands (ATM INTERFACE+ Prompt)” on page 300
- “ATM-LLC Monitoring Commands” on page 303
- “ATM and Virtual ATM Dynamic Reconfiguration Support” on page 303

---

### Accessing the ATM Interface Configuration Process

Use the following procedure to access the configuration process.

1. At the OPCON prompt, enter **talk 6**. (For more detail on this command, refer to “What is the OPCON Process?” on page 31.) For example:

```
* talk 6
  Config>
```

The CONFIG prompt (Config>) displays on the console. If the prompt does not appear when you first enter configuration, press **Return** again.

2. At the CONFIG prompt, enter the **list devices** command to display the network interface numbers for which the device is currently configured.
3. Record the interface numbers. If ATM is not specified as an interface, then create an ATM interface by using the **add device** command at the Config> prompt.
4. Enter the **network** command and the number of the ATM interface you want to configure. For example:

The ATM configuration prompt (ATM Config>), is displayed.

---

### ATM Configuration Commands

This section summarizes the ATM configuration commands. Enter the commands at the ATM config> prompt.

*Table 39. ATM Configuration Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Interface	Displays the ATM Interface Config> prompt from which you can list, change, or configure the ATM Interface. <ul style="list-style-type: none"><li>• Add an ESI.</li><li>• List the current configuration or list ESIs.</li><li>• Remove an ESI.</li><li>• Set parameters of the ATM network.</li><li>• Enable or disable an ESI.</li><li>• Exit</li></ul>

## ATM Configuration Commands (Talk 6)

Table 39. ATM Configuration Command Summary (continued)

Command	Function
Le-client	Displays the LE Client Config> prompt from which you can list, change, or configure the LAN Emulation Client Interface as described in “Chapter 26. Using LAN Emulation Clients” on page 305. <ul style="list-style-type: none"><li>• Add a LAN Emulation Client (LEC) for a token-ring or Ethernet emulated LAN.</li><li>• Configure a LEC by network #. This command displays the LE Config&gt; prompt, from which you can configure a specific LAN Emulation Client (LEC).</li><li>• List LAN Emulation Clients (LECs).</li><li>• Remove a LAN Emulation Client (LEC).</li></ul>
Virtual ATM	Displays the ATM Virtual Interface Config> prompt from which you can list, add, or remove the ATM Virtual Interface as described in “ATM Virtual Interface Configuration Commands” on page 298
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## ATM Interface Configuration Commands

This section summarizes and then explains the commands for configuring a specific ATM interface.

Enter the commands at the ATM INTERFACE> prompt.

Table 40. ATM INTERFACE Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Adds an ESI.
List	Lists the current configuration or list ESIs.
Qos	Displays the ATM I/F 0 QoS Config> prompt from which you can configure Quality of Service as described in “QoS Configuration” on page 293.
Remove	Removes an ESI.
Set	Sets parameters of the ATM network.
Disable	Disables an ESI.
Enable	Enables an ESI.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Add

Use the **add** command to add an ESI to your ATM configuration.

Octets 14–19 of an ATM address are the End System Identifier (ESI). Each end system attached to the same switch must use a disjoint set of ESIs. When an end system activates, it attempts to register its ESIs with its ATM switch using ILMI. The switch forces all of its registered ESIs to be unique.

#### Syntax:

**add** esi esi-address

**esi** esi-address

Address of End System Identifier.

## ATM Interface Configuration Commands (Talk 6)

**Valid Values:** Any 12 hexadecimal digits

**Default Value:**  
none

### List

Use the **list** command to list the configuration of this ATM device or to list the set of configured ESIs.

**Syntax:**

```
list                configuration  
                    esi
```

**configuration**

Lists the ATM device configuration. For an explanation of the listed fields, see “Set” on page 294.

**Example: list con**

```
ATM Configuration  
Interface (net) number = 0  
Maximum VCC data rate Mbps = 155  
Maximum frame size = 9234  
Maximum number of callers = 209  
Maximum number of calls = 1024  
Maximum number of parties to a multipoint call = 512  
Maximum number of Selectors that can be configured = 200  
UNI Version = UNI 3.0  
Packet trace = OFF
```

**esi** Lists the ESIs in the ATM configuration.

**Example: list esi**

```
ATM INTERFACE> list esi  
  
      ESI                Enabled  
-----  
000000000009          YES  
000000000100          YES
```

### QoS Configuration

Use the **qos-configuration** command to display the ATM I/F 0 QOS Config> prompt from which you can configure Quality of Service as described in “QoS Configuration”.

**Syntax:**

```
qos-configuration
```

### Remove

Use the **remove** command to remove an ESI from your ATM configuration. All ATM components using this ESI should be reconfigured to use a different ESI. An ATM component that attempts to use a removed ESI may not activate on the next device restart.

**Syntax:**

```
remove                esi esi-address
```

## ATM Interface Configuration Commands (Talk 6)

**esi** *esi-address*

Address of End System Identifier.

**Valid Values:** Any 12 hexadecimal digits

**Default Value:**  
none

## Set

Use the **set** command to specify ATM network parameters.

### Syntax:

**set** max-callers  
max-calls  
max-config-selectors  
max-data-rate  
max-frame  
max-mp-parties  
network-id  
trace  
uni-version

### max-callers

Sets the maximum number of entities on the device that use the ATM interface. Each LEC, Classical IP Client, and 1483 bridge interface qualifies as a user of the ATM interface. Increasing this parameter allows more users of the interface and uses more system memory.

**Valid Values:**

An integer in the range 64 – 1024

**Default Value:**

209

**Example:**

```
ATM INTERFACE> set max-callers 25
```

### max-calls

Sets the maximum number of switched virtual circuits (SVCs) that can exist on this ATM device. Every point-to-point and point-to-multipoint SVC uses system resources. This parameter helps limit the system resources reserved for signaling and switched connections. Increasing this parameter will allow more simultaneous SVCs. However, more system memory will be required to manage these connections.

**Valid Values:**

An integer in the range 64 - 10500

**Default Value:**

1024

**Example:**

```
ATM INTERFACE> set max-calls 500
```

### max-config-selectors

Sets the maximum number of selectors under your specific control.

## ATM Interface Configuration Commands (Talk 6)

The selector is used to distinguish different users on the same end system. VCC setup requests are routed in the following hierarchical fashion: ATM switches route to the destination ATM switch using the Network Prefix, the destination ATM switch routes to the destination end system using the ESI, and the end system notifies the destination user based on the selector.

Each ESI can have up to 255 associated selectors (0x00 through 0xff). The range of selectors is partitioned into two subranges, a configured selector range and an automatically assigned selector range. The ATM interface parameter `max-configured-selector` gives the upper bound on the configured selector range.

The ATM components on the device have various ways of choosing a selector. Some components require you to explicitly configure a selector from the configured selector range. Other components, such as Classical IP clients, allow the selector to be automatically assigned at run-time. You do not have to choose the selector because the device does this when it activates. This selector is not guaranteed to be consistent across device restarts. Automatic selector assignment is useful only for those ATM components whose ATM address does not have to be already known by other network devices.

The relative sizes of the selector range can be modified to conform to the types and numbers of ATM users on the device.

**Valid Values:**

0 – 255 (0x00 – 0xFF)

**Default Value:**

200

**Note:** The selector is byte 20 of a 20-byte ATM address.

**Example:**

```
ATM INTERFACE> set max-config-selectors 225
```

**max-data-rate** *speed*

Sets the default and upper bound for VCC traffic parameters of most LANE and CIP connections. For example, this is the default PCR for best-effort VCCs initiated by LE Clients. Signaled SCRs and PCRs cannot exceed this limit. The default value should be satisfactory in most situations. An example of a situation where it is beneficial to change this value would be if the majority of the stations use 25-Mbps adapters. In this case, it may be desirable to limit the data rate on VCCs to 25 Mbps so that the lower speed stations are not overwhelmed with frames from the device. The units for this parameter are Mbps.

**Valid Values:**

25

100

155

**Default Value:**

155

**Example:**

```
ATM INTERFACE> set speed 155
```

**max-frame**

Sets the maximum number of octets permitted in any data frame sent or

## ATM Interface Configuration Commands (Talk 6)

received on the ATM interface. System memory is allocated based upon this parameter. Increasing the max-frame requires more system memory, but allows processing of larger frames.

All device entities using the ATM interface must use a maximum frame size less than or equal to the max-frame-size of the ATM interface. This includes all LECs and 1483 bridge interfaces.

**Valid Values:**

An integer in the range 512 - 31000

**Default Value:**

9234

**Example:**

```
ATM INTERFACE> set max-frame 1000
```

### max-mp-parties

Sets the maximum number of leaves on a point-to-multipoint connection initiated by the device. This parameter affects system memory allocation. Increasing this value is necessary if the device must set up point-to-multipoint connection(s) to a large number of destinations.

**Valid Values:**

An integer in the range 1 – 5000

**Default Value:**

512

**Example:**

```
ATM INTERFACE> set max-mp-parties 300
```

### network-id

Sets the network id of the ATM interface. Multiple ATM interfaces should have the same network id if there is ATM connectivity between the interfaces.

**Valid Values:**

0 - 255

**Default Value:**

0

**trace** Sets the packet tracing parameters on the interface. Packet tracing can be enabled or disabled on a range of VPI/VCI values. Common VPI/VCI values to trace are:

- 0/5 for signaling packets
- 0/16 for ILMI packets.

**Valid Values:**

on, off

**Default Value:**

off

You are prompted for the VPI/VCI range you want to trace.

**Beginning VPI Valid Values:**

0 – 255

**Default Value:**

0

**Ending VPI Valid Values:**

0 - 255

**Default Value:**

255

**Beginning VCI Valid Values:**

0 - 65535

## ATM Interface Configuration Commands (Talk 6)

**Default Value:**

0

**Ending VCI Valid Values:**

0 - 65535

**Default Value:**

65535

**Example:**

```
ATM INTERFACE> set trace on
beginning of VPI range [0]? 0
end of VPI range [255]? 0
beginning of VCI range [0]? 5
end of VCI range [65535]? 5
```

### uni-version

Sets the User Network Interface (UNI) version used by the ATM interface with communicating with the attached ATM switch. If the UNI versions are configured on the ATM switch and ATM device interface to a specific version (not AUTO-DETECT), the UNI versions must match.

If the UNI version is configured as AUTO, the ATM device attempts to learn the UNI version to use from the switch.

In UNI AUTO-DETECT mode, if the switch does not respond to the query for UNI version, the default is UNI 3.0. If the switch responds with a value other than UNI 3.0 or UNI 3.1, the default is UNI 3.1.

**Valid Values:**

[UNI 3.0|UNI 3.1|AUTO-DETECT|None]

**Default Value:**

UNI 3.0

**Note:** Must be compatible with the ATM switch.

**Example:**

```
ATM INTERFACE> set uni-version 3.0
```

## Enable

Use the **enable** command to enable an ESI in the configuration of your ATM device. The ATM interface attempts to register only enabled ESIs when it activates.

**Syntax:**

**enable** esi *esi-address*

**esi** *esi-address*

Address of End System Identifiers.

**Valid Values:**

Any 12 hexadecimal digits

**Default Value:**

none

**Example: enable esi**

```
ATM INTERFACE> enable esi 00:00:00:00:00:09
```

## Disable

Use the **disable** command to disable an ESI in the configuration. ATM components using disabled ESIs will not become active on the next device restart.

**Syntax:** **disable** esi *esi-address*

## ATM Interface Configuration Commands (Talk 6)

**esi esi-address**

Address of End System Identifiers.

**Valid Values:**

Any 12 hexadecimal digits

**Default Value:**

none

**Example: disable esi**

```
ATM INTERFACE> disable esi 00:00:00:00:00:09
```

---

## Accessing the Virtual ATM Interface Configuration Process

From the ATM Config> prompt of a selected real ATM interface, use the **Virtual ATM** command to enter the Virtual ATM configuration command mode.

---

## ATM Virtual Interface Configuration Commands

This section summarizes the ATM virtual interface configuration commands. Enter the commands at the ATM virtual interface config> prompt.

*Table 41. ATM Virtual Interface Configuration Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Add	Adds a virtual ATM interface.
List	Lists the current configured virtual ATM interfaces.
Remove	Removes the virtual ATM interface from the current configuration.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### Add

Use the **add** command to add an ATM virtual interface. A new ATM virtual interface is added to the corresponding ATM real interface (the configuration menu from which this ATM virtual interface configuration menu is accessed). The net/interface number assigned to the newly created ATM virtual interface is displayed and it is one number greater than the current largest interface number.

**Syntax:**

**add**

**Example:**

```
ATM Virtual Interface config> add
Added ATM Virtual Interface Net as interface 5 on physical ATM interface 0
ATM Virtual Interface config>
```

### List

Use the **list** command to list configured ATM virtual interfaces defined on the current real ATM interface.

**Syntax:**

**list**

**Example:**



## ATM Virtual Interface Configuration Commands (Talk 6)

```
ATM Virtual Interface config> list
                                ATM Virtual Interface Nets
-----
  ATM interface number = 0
  ATM Virtual Interface Net interface number = 5
ATM Virtual Interface config>
```

### Remove

Use the **remove** command to delete an ATM virtual interface. The virtual ATM interface on the real ATM interface with the specified interface number will be removed from the SRAM configuration records. If you do not specify an interface number, the last ATM virtual interface on this real ATM interface will be deleted. If you enter a question mark (?), all ATM virtual interfaces on the current real ATM interface will be listed and you can select from that list the interface you want to remove.

#### Syntax:

```
remove                n
```

#### Example: remove 5

```
Virtual ATM 5 deleted successfully.
ATM Virtual Interface config>
```

---

## Accessing the ATM Monitoring Process

Use the following procedure to access the ATM monitoring commands. This process gives you access to an ATM's *monitoring* process.

1. At the OPCON prompt, enter **talk 5**. (For more detail on this command, refer to "What is the OPCON Process?" on page 31.) For example:

```
* talk 5
+
```

The GWCON prompt (+) is displayed on the console. If the prompt does not appear when you first enter the console, press **Return** again.

2. Enter **interface** at the + prompt to display a list of configured interfaces.
3. Record the interface numbers.
4. Enter **network** followed by the number of the ATM interface.

```
+ network 1
ATM+
```

The ATM monitoring prompt (ATM+) is displayed.

---

## ATM Monitoring Commands

This section summarizes the ATM monitoring commands for monitoring ATM interfaces. Enter the commands at the ATM+ prompt.

Table 42. ATM monitoring command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.

## ATM Monitoring Commands (Talk 5)

Table 42. ATM monitoring command Summary (continued)

Command	Function
Interface	Displays the ATM Interface+ prompt from which you can monitor the ATM Interface, as described in “ATM Interface Monitoring Commands (ATM INTERFACE+ Prompt)”.
Atm-llc	Displays the ATM LLC+ prompt from which you can monitor endpoints, a set of user clients, and a set of ATM channels.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Interface

Displays the ATM Interface+ prompt, described in “ATM Interface Monitoring Commands (ATM INTERFACE+ Prompt)”.

**Syntax:**

interface

### ATM-LLC

Displays the ATM-LLC+ prompt, described in “ATM-LLC Monitoring Commands” on page 303.

**Syntax:**

atm-llc

---

## ATM Interface Monitoring Commands (ATM INTERFACE+ Prompt)

This section summarizes and then explains the commands for monitoring a specific ATM interface.

Enter the commands at the ATM INTERFACE+ prompt.

Table 43. ATM INTERFACE monitoring command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Lists ATM addresses and VCCs.
Trace	Starts/Stops packet tracing on a specified VPI/VCI range. Trace can be viewed by ELS.
Wrap	Starts/Stops a loopback test on the VCC.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### List

Use the **list** command to list various categories of ATM data.

**Syntax:**

list addresses  
all  
circuit  
vccs  
reserved-bandwidth

## ATM Interface Monitoring Commands (Talk 5)

### addresses

Lists the ATM addresses, along with a descriptive name, in use on the device.

#### Example:

```
ATM INTERFACE+ list addresses
```

```

           ATM Address                               Name
-----
3999999999999999999900009999020000041347391804  LEC 1 'eth1'
3999999999999999999900009999020000041347391802  LES/BUS 'eth1'
```

**all** Lists all of the following:

- Addresses
- Circuit statistics
- VCCs
- Reserved Bandwidth

**circuit** Lists the statistics for a particular VCC by specifying the particular VCI-VPI pair. You can also specify the circuit on the command line; for example: list circuit 33.

#### Example:

```
ATM INTERFACE+ list circuit
VPI [0]?
VCI [32]?33
```

```

Frames transmitted =      2 Bytes transmitted =      216
Frames received   =      2 Bytes received   =      216
```

**vccs** Lists all the VCCs established by the device. The VCCs may be permanent (PVC) or switched (SVC), point-to-point or point-to-multipoint, and each is identified by a unique VPI/VCI. The trace command uses the VPI/VCI value for a VCC to perform packet tracing over a particular VCC.

#### Example:

**P-P** point to point VCC

**P-MP** point to multipoint VCC

**ILMI** Interim Local Management Interface VCC

**SAAL** signaling VCC

**Bx-y** Internally bound VCC to VPI x, VCI y

**Sx-y** Internally spliced VCC to VPI x, VCI y

### reserved-bandwidth

Lists the reserved bandwidth on the ATM Interface.

#### Example:

```
ATM INTERFACE+ list reserved-bandwidth
Line Rate          : 155000 Kbps
Peak Reserved Bandwidth : None
Sustained Reserved Bandwidth : None
```

## Trace

Use the **trace** command activate packet tracing over a specified range of VPI/VCI values. You can view trace data by using ELS as described in “View” on page 185.

#### Syntax:

```
trace                               list
```

## ATM Interface Monitoring Commands (Talk 5)

on

off

**list** Displays the current packet tracing options on the ATM interface.

**Example:**

```
ATM Interface+ trace
on | off | list []? list
Packet trace is ON
Range of VPIs to be traced:    0 -    0
Range of VCIs to be traced:   32 -   39
```

**on** Starts packet tracing on all active VCCs within the specified VPI/VCI range.

**Example:**

```
ATM Interface+ trace on
beginning of VPI range [0]?
end of VPI range [0]?
beginning of VCI range [32]?
end of VCI range [65535]? 39
```

**off** Stops packet tracing on all VCCs.

**Example:**

```
ATM Interface+ trace off
ATM Interface+ trace list
Packet trace is OFF
```

## Wrap

Use the **wrap** command to perform a loopback data test on the ATM interface of the adapter. Wrap can be issued on a per VC basis by specifying VPI-VCI pairs. Data is looped back internally.

You can selectively start a wrap, stop a wrap, or display the current wrap settings.

If you stop or display a wrap, the following statistics will be displayed:

- Wrap transmits
- Wrap receives
- Wrap transmit errors
- Wrap receive errors
- Wrap receive timeouts

For display, the current wrap statistics are displayed.

For stop, the final wrap statistics are displayed.

**Syntax:**

```
wrap                display
                        start
                        stopy
```

**display**

Displays the current wrap settings.

**start** Starts the wrap procedure and specifies the VPI-VCI length of pattern and the pattern itself.

**Example:**

```
ATM Interface+ wrap start
VPI [0]?
VCI [32]?
wrap pattern length [32]?
Enter 32-byte wrap pattern: [ABCDEFGHijklmnopqrstuvwxyz123456]?
```

## ATM Interface Monitoring Commands (Talk 5)

**stop** Stops the wrap procedure and displays final wrap statistics.

---

### ATM-LLC Monitoring Commands

This section explains the commands for monitoring ATM LLC multiplexing.

Enter the commands at the ATM-LLC+ prompt.

*Table 44. ATM LLC Configuration Command Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Lists various options
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### List

Use the **list** command to list various categories of ATM LLC monitoring data.

#### Syntax:

```
list                endpoints  
                    channels
```

#### endpoints

Lists the ATM addresses in use by protocols using the ATM-LLC multiplexing function on the device. The endpoint is displayed as the End System Identifier and the Selector.

#### Example: list endpoints

```
ATM-LLC+ list endpoints
```

#### channels

Lists the channels in use by protocols using the ATM-LLC multiplexing function on the device.

#### Example: list channels

```
ATM-LLC+ list channels
```

---

### ATM Virtual Interface Monitoring Commands

Monitoring the ATM virtual interface is done using the ATM LLC monitoring commands. See “ATM-LLC Monitoring Commands” for additional information.

---

### ATM and Virtual ATM Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

ATM and Virtual ATM supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

## ATM Virtual Interface Monitoring Commands (Talk 5)

### GWCON (Talk 5) Activate Interface

ATM and Virtual ATM supports the GWCON (Talk 5) **activate interface** command with the following consideration:

You cannot activate an ATM base net.

All ATM and Virtual ATM interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

### GWCON (Talk 5) Reset Interface

ATM and Virtual ATM supports the GWCON (Talk 5) **reset interface** command with the following consideration:

You cannot reset an ATM base net.

All ATM and Virtual ATM interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.

---

## Chapter 26. Using LAN Emulation Clients

This chapter describes LAN Emulation Clients (LECs). It includes the following sections:

- “LAN Emulation Client Overview”

---

### LAN Emulation Client Overview

On the router, LECs serve the purpose of “ports” or “interfaces” on traditional routers and bridges. The router bridges and routes traffic between ports by receiving and transmitting traffic through its LECs.

LEC has two prompt levels:

1. `LE Client Config>` lets you enter commands that control the environment of all your LECs. The commands for this prompt level are described in “Configuring LAN Emulation Clients” on page 307
2. One of the commands, **config**, gets you to another prompt level, `LEC Config>`, at which you can enter commands to configure a specific LEC.

An explanation of commands for LAN Emulation Clients follows.





---

## Chapter 27. Configuring and Monitoring LAN Emulation Clients

This chapter describes how to configure LAN Emulation Clients (LECs). It includes the following sections:

- “Configuring LAN Emulation Clients”
- “Configuring an ATM Forum-Compliant LE Client” on page 308
- “Accessing the LEC Monitoring Environment” on page 325
- “LEC Monitoring Commands” on page 326
- “LEC Dynamic Reconfiguration Support” on page 336

---

### Configuring LAN Emulation Clients

This section summarizes and explains the commands for configuring and using the set of LE Clients on a particular ATM interface.

To get to the LE Client Config> prompt, enter **le-c** at the ATM Config> prompt as described in “ATM Configuration Commands” on page 291.

Enter the commands at the LE Client Config> prompt under the ATM Config> prompt, as described in “ATM Configuration Commands” on page 291.

*Table 45. LAN EMULATION Client Configuration Commands Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Adds a LEC for the following types of ATM Forum-compliant Emulated LANs architectures: <ul style="list-style-type: none"><li>• Ethernet</li><li>• Token Ring</li></ul>
Config	Gets you to the LEC Config> prompt, from which you can configure a specific LAN Emulation Client.
List	Lists the LEC.
Remove	Removes a LEC.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Add

Use the **add** command to add a LEC for a Token-Ring or Ethernet emulated LAN.

#### Syntax:

```
add                Ethernet
                   Token Ring
```

#### token-ring

Token-ring emulated LAN

#### Example: add token ring

```
LE Client Config> add token-ring
Added Emulated LAN as interface 3
```

#### ethernet

Ethernet emulated LAN

#### Example: add ethernet

## LE Client Config>

```
LE Client Config> add ethernet
Added Emulated LAN as interface 2
```

## Config

Use the **config** command to get you to the LEC Config> prompt, from which you can configure the details of a specific LAN Emulation Client.

### Syntax:

**config** interface#

### interface#

An integer number assigned by the router when the LEC was added to the configuration. Use the **list** command to determine the interface number assigned to the LEC.

### Example: config

```
LE Client Config> config 3
ATM LAN Emulation Client configuration
```

## List

Use the **list** command to list the LAN emulation clients.

### Syntax:

**list**

### Example:

```
LE Client Config> list
ATM Forum Compliant Emulated LANs
-----
Physical ATM interface number = 0
LEC interface number = 1
Emulated LAN type = Token Ring Forum Compliant
Emulated LAN name =
```

## Remove

Use the **remove** command to remove a LEC. You must specify the interface number that was assigned when the LEC was added to the configuration. Use the **list** command to determine the interface number assigned to the LEC.

### Syntax:

**remove** interface#

### interface#

An integer number assigned by the router.

---

## Configuring an ATM Forum-Compliant LE Client

Use this process to access the appropriate LEC Config> prompt.:

1. Use the **config** command at the LE Client Config> prompt to access the appropriate LEC interface number, or use the **network** configuration command with the appropriate LEC interface number.
2. Enter the appropriate commands at either the Ethernet Forum Compliant LEC Config> prompt or the Token Ring Forum Compliant LEC Config> prompt. Commands in the following table apply to both Token-Ring and Ethernet LECs except where indicated.

## Configuring Forum LE Clients

This section explains the commands for configuring an ATM Forum-compliant LAN Emulation Client.

Table 46. LAN Emulation Client Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
ARP-Configuration	Allows you to configure the LE-ARP configuration for the ATM Forum-compliant client
Frame	Sets the NetWare IPX encapsulation type.
IP-Encapsulation	Sets the IP encapsulation as Ethernet (type X'0800') or IEEE (802.3 with SNAP). Applies only to Ethernet LECs.
List	Lists the LAN Emulation Client configuration.
LLC	Accesses the LLC Config> configuration prompt for Token Ring LECs.
QoS-Configuration	Gets you to the e!an-x LEC QoS Config> prompt from which you can configure Quality of Service as described in LE Client QoS Configuration Commands in <i>Using and Configuring Features</i> .
RIF-Timer	Sets the maximum amount of time that information in the RIF is maintained before it is refreshed. Applies only to Token-Ring LECs.
Set	Sets the LAN Emulation Client parameters.
Source-routing	Used to enable or disable source-route bridging. Applies only to Token-Ring LECs.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## ARP Configuration

Use the **arp-configuration** command to configure the static LE-ARP entries for the ATM forum-compliant LAN Emulation Client.

### Syntax:

**arp-configuration**

### Example:

```
Token Ring Forum Compliant LEC Config> arp-configuration  
ATM LAN Emulation Clients ARP configuration
```

Table 47. ATM LAN Emulation Client ARP Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Adds an LE-ARP cache entry using a MAC or route descriptor ARP.
Config	Sets cache entry QoS parameter values.
List	Lists configured ARP cache entries.
Remove	Removes an ARP cache entry.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Add

Use the **add** command to add an ARP cache entry using the MAC address or a route descriptor.

## Configuring Forum LE Clients

MAC addresses, and route descriptors are entered as strings of hexadecimal characters with or without optional separator characters between bytes. Valid separator characters are dashes (-), periods (.), or colons (:).

### Syntax:

```
add                               mac  
                                     route-descriptor
```

### Example 1:

```
ARP config for LEC>add mac  
MAC address of LE ARP Entry []? 123456789098  
ATM address in 00.00.00.00.00.00:... form []? 390f000000000000000000000000123456789098  
Destination Type - REMOTE or LOCAL [Remote]?
```

### Example 2:

```
ARP config for LEC>add route 12.34  
ATM address in 00.00.00.00.00.00:... form []? 390f0000000000000000000000001234567890988888  
ARP config for LEC>
```

## Config

Use the **Config** command to configure the permanent ARP cache entry QoS parameters for the ATM forum-specific LAN Emulation Client.

### Syntax:

```
config                             arp-entry-number
```

### Example:

```
ARP config for LEC> config  
ARP entry number [1]  
Configure LEC ARP entry
```

Table 48. ATM LAN Emulation Client ARP Config Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Set	Sets QoS parameter values.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### Set:

Use the **Set** command to configure the permanent ARP cache entry QoS parameters for the ATM forum-specific LAN Emulation Client.

### Syntax:

```
set                                 max-reserved-bandwidth  
                                     traffic-type  
                                     peak-cell-rate  
                                     sustained-cell-rate  
                                     qos-class  
                                     max-burst-size
```

### Example:

```
ARP entry 'identifier' config> set ?  
MAX-RESERVED-BANDWIDTH  
TRAFFIC-TYPE
```

PEAK-CELL-RATE  
 SUSTAINED-CELL-RATE  
 QOS-CLASS  
 MAX-BURST-SIZE

See Configuring and Monitoring Quality of Service (QoS) in *Using and Configuring Features* for detailed information about the QoS parameters.

### List

Use the **list** command to display information about ARP configuration.

### Remove

Use the **remove** command to remove an configured MAC address or Route Descriptor LE-ARP entry.

Select the ARP entry number to be removed from the list provided.

#### Syntax:

**remove** *arp-entry-number*

## Frame

Use the **frame** command to set the NetWare IPX encapsulation type. The command options differ depending on the type of LEC (Token-Ring or Ethernet). For Token-Ring LECs, enter one of the following:

Option	Description	Syntax
Token-Ring using MSB	Uses the standard 802.2 IPX header with the noncanonical Token-Ring address bit ordering (MSB).	frame token-ring msb
Token-Ring using LSB	Uses the 802.2 IPX header with the canonical address bit ordering (LSB).	frame token-ring lsb
Token-Ring with 802.2 SNAP using MSB	Uses the 802.2 format with a SNAP header and noncanonical address bit ordering. This encapsulation is used primarily in bridging environments.	frame token-ring_snap msb
Token-Ring with 802.2 SNAP using LSB	Uses the 802.2 format with a SNAP header and canonical address bit ordering.	frame token-ring_snap lsb
Ethernet 2.0	Uses Ethernet version 2.0 protocol 81-37.	frame ethernet_II
Ethernet 802.2	Uses Ethernet 802.3 with 802.2 SA E0.	frame ethernet_8022
Ethernet 802.3	Uses Ethernet 802.3 without any 802.2 header.	frame ethernet_802.3
Ethernet SNAP	Uses 802.3, 802.2 with SNAP PID 00-00-00-81-37.	frame ethernet_SNAP

#### Syntax:

**frame** *ipx-encapsulation type*

**Note:** The frame command cannot be used in the network configuration process to set the IPX encapsulation unless the interface has been configured with IPX.

## Configuring Forum LE Clients

The IPX encapsulation can also be set in the IPX configuration environment. Refer to the chapter entitled “Configuring and Monitoring IPX” in the *Protocol Configuration and Monitoring Reference* for details.

### Example:

```
frame token_ring msb
```

## IP-Encapsulation (for Ethernet ATM Forum-Compliant LEC only)

Use the **IP-encapsulation** command to select Ethernet (Ethernet type X'0800'), IEEE 802.3 (Ethernet 802.3 with SNAP), or both.

The option **both** enables the 2216 to use Ethernet encapsulation to transmit to hosts that have Ethernet encapsulation and to use IEEE 802.3 encapsulation to transmit to hosts that have IEEE 802.3 encapsulation. If your Ethernet LAN includes some hosts that use one type of encapsulation and some that use the other, entering **both** enables all of them to communicate.

The option **both** applies only to unicast frames. If you enter **both**, you are prompted to enter either **ethernet** or **ieee-802.3** for broadcast and multicast frames.

### Syntax:

#### IP-encapsulation

- ethernet
- ieee-802.3
- both

### Example:

```
Ethernet Forum Compliant LEC Config> ip-encapsulation both
How would you like IP broadcast/multicast frames to be sent (ETHER/IEEE-802.3) [ETHER]?
```

## List

Use the **list** command to list the LE client configuration.

### Syntax:

#### list

## LLC

Logical Link Control can be thought of as a “sub-protocol”. It is not accessed directly from either the Talk 6 (configuration) or the Talk 5 (console) environment. Instead, it is accessed from the Token Ring LEC configuration menu by entering an **LLC** command.

Use the **llc** command to access the LLC Config> prompt. See “LLC Configuration Commands” on page 324 for more information.

### Syntax:

#### llc

## QoS

Use the **qos-configuration** command to get you to the LEC QoS Config> prompt from which you can configure Quality of Service as described in LE Client QoS Configuration Commands in *Using and Configuring Features*.

**Syntax:**qos-configuration**RIF-Timer (for Token-Ring Forum-compliant LEC only)**

Use the **RIF-Timer** command to set the maximum amount of time that information in the RIF is maintained before it is refreshed. Range is 0 to 4096. The default is 120 seconds.

**Syntax:**rif-timer *value***Example:**rif-timer 100**Set**

Use the **set** command to set LE Client parameters.

**Syntax:**

set arp-aging-time  
arp-cache-size  
arp-queue-depth  
arp-response-time  
auto-config  
best-effort-peakrate  
bus-connect-retries  
conn-completion-time  
control-timeout  
data-direct-timeout  
data-direct-vcc-mode  
elan-name  
esi-address  
flush-timeout  
forward-delay  
forward-disconnect-timeout  
frame-size  
initial-control-timeout  
lecs-atm-address  
les-atm-address  
mac-address  
multicast-send-avg  
multicast-send-peak

## Configuring Forum LE Clients

multicast-send-type  
multiplier-control-timeout  
path-switch-delay  
reconfig-delay-min  
reconfig-delay-max  
retry-count  
selector  
trace  
unknown-count  
unknown-time  
vcc-timeout

### arp-aging-time

Sets ARP aging time. This is the maximum time that a LEC will maintain an entry in its LE\_ARP cache in the absence of a verification of that relationship. A larger aging time may result in a faster session setup time, but may also use more memory and reacts slower to changes in network configuration.

#### Valid Values:

An integer number of seconds in the range of 10 to 300.

#### Default Value:

300

#### Example:

```
LEC Config> set arp-aging-time 200
```

### arp-cache-size

Sets the number of entries in the ARP cache. The size of the ARP cache limits the number of simultaneous data direct VCCs. Larger ARP caches require more memory, but permit the client to simultaneously converse with a larger number of destinations.

#### Valid Values:

An integer number in the range of 10 to 65535.

#### Default Value:

5000

#### Example:

```
LEC Config> set arp-cache-size 10
```

### arp-queue-depth

Sets the maximum number of queued frames per ARP cache entry. The LEC enqueues frames when switching the data path from the Multicast Send VCC to a Data Direct VCC. Frames passed to the LEC for transmission will be discarded if the queue is full. A larger queue requires more memory, but results in fewer discarded frames during the data path switch.

#### Valid Values:

An integer number in the range of 0 to 10.



**Default Value:**

5

**Example:**

```
LEC Config> set arp-queue-depth 10
```

**arp-response-time**

Sets expected ARP response time. This value controls how frequently an unanswered LE ARP request is retried. Larger values result in fewer LE ARPs, which causes less traffic and possibly increase the amount of time before a Data Direct VCC is established.

**Valid Values:**

An integer number of seconds in the range of 1 to 30.

**Default Value:**

1 second

**Example:**

```
LEC Config> set arp-response-time 20
```

**auto-config**

Specifies whether this LEC uses LECS auto-config mode. Specify YES or NO. The LEC may contact the LECS to obtain the address of its LES and various other configuration parameters.

**Valid Values:**

If YES, then you do not have to configure the ATM address of the LES.

If NO, then you *must* configure the ATM address of the LES using the **set les-atm-address** command as described on page 318.

**Default Value:**

NO

**Example:**

```
LEC Config> set auto-config yes
```

**best-effort-peakrate**

Sets the Best Effort Peak Rate. Used when establishing best effort multicast send connections.

The maximum peak rate depends on the maximum data rate of the ATM device.

Specify an integer from 1 to the maximum peak rate in kbps (the definition is the maximum data rate) as follows:

- If ATM maximum data rate is 25 Mbps, the maximum peak rate is 25,000 kbps.
- If ATM maximum data rate is 155 Mbps, the maximum peak rate is 155,000 kbps.

**Valid Values:**

An integer number in the range of 1 - device maximum data rate.

**Default Value:**

155000

**Example:**

```
LEC Config> set best-effort-peakrate 24000
```

## Configuring Forum LE Clients

### **bus-connect-retries**

This parameter sets the maximum number of times that the LEC will attempt to reconnect to the BUS before returning to the initial state.

#### **Valid Values:**

0 - 2

#### **Default Value:**

1

### **connection-completion-time**

Sets the connection completion time. This is the time interval in which data or a READY\_IND message is expected from a calling party.

When a Data Direct VCC is established to the client, the LEC expects data or a READY\_IND message within this time period. The LEC will not transmit frames over a Data Direct VCC established to it until receiving data or a READY\_IND. This parameter value controls the amount of time which passes before the LEC issues a READY QUERY (in hopes of receiving a READY\_IND). Smaller values lead to faster response times, but also to unnecessary transmissions.

#### **Valid Values:**

An integer number of seconds in the range of 1 to 10.

#### **Default Value:**

4

#### **Example:**

```
LEC Config> set connection-completion-time 5
```

### **control-timeout**

This parameter sets the maximum cumulative control timeout of a request.

A current timeout value is initialized to the value of *initial-control-timeout*. If a response to a request is not received within the current timeout value, the current timeout is multiplied by the value of the *multiplier-control-timeout* and the request is reissued. Each time the current timeout value expires, this process is repeated until the current timeout value exceeds the value of *control-timeout*.

#### **Valid Values:**

An integer number of seconds in the range of 10 to 300.

#### **Default Value:**

30

#### **Example:**

```
LEC Config> set control-timeout 100
```

### **data-direct-timeout**

Specifies the timeout value for the data direct VCC. This parameter limits the time the Data Direct VCCs are left up without the LEC having a connection to the LES/BUS. If the LEC rejoins a LES/BUS before the timer expires, the time is stopped.

#### **Valid Values:**

10 - 300 seconds

#### **Default Value:**

30

### **data-direct-vcc-mode**

Specifies whether persistent Data Direct VCC mode is enabled or disabled. When the Data Direct VCC mode is enabled, if the LEC loses its connection to the LES/BUS, the Data Direct VCCs are not dropped and the reconnect timeout timer is started. The LEC will continue to try to reconnect to the LES/BUS. If the LEC cannot reconnect to the LES/BUS before the **data-direct-timeout** expires, all Data Direct VCCs will be disconnected.

#### **Valid Values:**

yes or no

#### **Default Value:**

no

### **elan-name**

Specifies name of the ELAN that the LEC wishes to join. This is the ELAN name sent to the LECS in the configure request (if the LEC autoconfigures) or to the LES in the join request. The LECS or LES may return a different ELAN name in the response.

#### **Valid Values:**

Any character string length of 0 - 32 bytes.

#### **Default Value:**

Blank

**Note:** A blank name (0 length string) is valid.

#### **Example:**

```
LEC Config> set elan-name FUZZY
```

### **esi-address**

Sets the ESI portion of the LEC's ATM address.

Specify the ESI portion (octets 13 through 19) of the LEC's ATM address. The ESI and selector combination of the LEC must be unique among all LAN emulation components on the device.

#### **Valid Values:**

Any 12 hexadecimal digits.

#### **Default Value:**

Burned-in ESI

#### **Example:**

```
set esi
Select ESI
(1) Use burned in ESI
(2) 11.22.33.44.55.66

Enter selection [1]?
```

### **flush-timeout**

Sets the flush timeout. This is the time limit to wait to receive the LE\_FLUSH\_RESPONSE after the LE\_FLUSH\_REQUEST has been sent before taking recovery action. During recovery, any queued frames are dropped and a new flush request is sent.

When switching from the multicast send to a data direct data path, the client sends a flush request over the multicast send VCC. Until a flush response is received, or until the path switch delay expires, frames are queued for the destination.

## Configuring Forum LE Clients

### Valid Values:

An integer number of seconds in the range of 1 to 4.

### Default Value:

4

### Example:

```
LEC Config> set flush-timeout 3
```

### forward-delay

Sets the forward delay. Entries in the LE ARP cache must be periodically re-verified. The forward delay time is the maximum amount of time a remote entry may remain in the cache during a network topology change. Larger aging times may result in stale (invalid) entries, but also cause less re-verification traffic.

### Valid Values:

An integer number of seconds in the range of 4 to 30.

### Default Value:

15

### Example:

```
LEC Config> set forward-delay 10
```

### forward-disconnect-timeout

This parameter sets the amount of time that a LEC will wait after losing its last Multicast Forward VCC from the BUS before returning to the initial state. This delay permits the BUS to attempt to reconnect to the client without returning to the initial state.

### Valid Values:

10 - 300 seconds

### Default Value:

60

### frame-size

Sets the frame size.

The value specified for frame-size must be equal to or less than the value specified for ATM max-frame using the ATM INTERFACE> **set max-frame** command as described on page 295.

### Valid Values:

1516

4544

9234

18190

### Default Value:

If the ELAN type is token ring, the default is 4544. If the ELAN type is Ethernet, the default is 1516.

### Example:

```
LEC Config> set frame-size 4544
```

### initial-control-timeout

This parameter sets the value of the initial control timeout used in the control timeout algorithm described in 316.

**Valid Values:**

1 - 10

**Default Value:**

5

**Example:**

```
LEC Config> set initial-control-timeout 10
```

**lecs-atm-address**

Specifies the ATM address of the LECS.

If the client is set to auto configure, it attempts to connect to a LECS. If it is unable to connect to a LECS, then it may try another LECS ATM address. The LECS ATM addresses that are tried, in order, are:

1. This configured LECS address
2. Any LECS address obtained through ILM1
3. The well-known LECS address defined by the ATM Forum.

No default is provided.

**Note:** This command should be entered on one command line. It is shown here on two lines because of spacing.

**Example:**

```
LEC Config> set lecs-atm-address
39.84.0F.00.00.00.00.00.00.00.01.10.00.5A.00.DE.AD.01
```

**les-atm-address**

Sets the LES ATM address. This command may be optional or required depending upon the setting of lecs-auto-config as described in the **set auto-config** command on page 315.

- If auto-config is YES, the les-atm-address is not configurable.
- If auto-config is NO, then the les-atm-address is required.

Specify the ATM address of the LES. No default is provided.

**Note:** This command should be entered on one command line. It is shown here on two lines because of spacing.

**Example:**

```
LEC Config> set les-atm-address
39.84.0F.00.00.00.00.00.00.00.01.10.00.5A.00.DE.AD.02
```

**mac-address**

Sets the MAC address for this LE client. You *may* specify that the client use the burned-in MAC address of the ATM interface, or you may specify a different MAC address. If you have two clients that are bridged together, they should use different MAC addresses.

If you have two clients and each client has IPv6 configured, these clients should use different MAC addresses.

This MAC address is registered with the LES when the client joins the ELAN.

**Valid Values:**

Any valid MAC address.

**Default Value:**

none

## Configuring Forum LE Clients

### Example:

```
LEC Config> set mac-address
Use adapter address for MAC? [No]
MAC address []: 10.00.5a.00.00.01
```

### multicast-send-avg

Sets the multicast send VCC average rate in kbps. Used by the LEC for reserving bandwidth on the VCC to the BUS. It specifies the forward and backward sustained cell rate used when setting up a reserved bandwidth multicast send VCC.

This parameter is only applicable when the multicast-send-type is reserved bandwidth. If multicast-send-avg equals multicast-send-peak, then a constant bit rate (CBR) multicast send is signalled. Otherwise, a variable bit rate (VBR) multicast send is signalled. Multicast-send-avg must be less than or equal to multicast-send peak.

A reserved bandwidth multicast send VCC may improve data transfer rates in congested networks, but reserving bandwidth and not using it wastes network resources.

When the multicast-send-type is reserved, then multicast-send-avg and multicast-send-peak must be specified.

### Example:

```
LEC Config> set multicast-send-avg 4000
```

### multicast-send-peak

Sets the multicast send peak rate in kbps. Used by LEC for reserving bandwidth on the VCC to the BUS. It specifies the forward and backward peak cell rate used when establishing a reserved bandwidth multicast send VCC.

This parameter is only applicable when the multicast-send-type is reserved bandwidth. If multicast-send-avg equals multicast-send-peak, then a constant bit rate (CBR) multicast send is signalled. Otherwise, a variable bit rate (VBR) multicast send is signalled. Multicast-send-avg must be less than or equal to multicast-send peak.

A reserved bandwidth multicast send VCC may improve data transfer rates in congested networks, but reserving bandwidth and not using it wastes network resources.

When the multicast-send-type is reserved, then multicast-send-avg and multicast-send-peak must be specified.

### Example:

```
LEC Config> set multicast-send-peak 155
```

### multicast-send-type

Sets the multicast send type. Specifies the method used by the LEC when establishing the multicast send VCC.

If multicast-send-avg equals multicast-send-peak, then a constant bit rate (CBR) multicast send is signalled. Otherwise, a variable bit rate (VBR) multicast send is signalled. Multicast-send-avg must at least equal multicast-send peak.

A reserved bandwidth multicast send VCC may improve data transfer rates in congested networks, but reserving bandwidth and not using it wastes network resources.

When the multicast-send-type is reserved, then multicast-send-no and multicast-send-peak must be specified.

**Valid Values:**

Best Effort or Reserved

**Default Value:**

Best Effort

**Example:**

```
LEC Config> set multicast-send-type best-effort
```

**multiplier-control-timeout**

This parameter sets the value of the control timeout multiplier used in the control timeout algorithm described on page 316.

**Valid Values:**

2 - 5

**Default Value:**

2

**Example:**

```
LEC Config> set multiplier-control-timeout 5
```

**path-switch-delay**

Sets the path switch delay.

The LEC must ensure that all frames sent through the BUS to a destination have arrived at the destination before it can start using a Data Direct VCC. This is accomplished using the flush protocol, or by waiting `path-switch-delay` seconds after sending the last packet to the BUS. Smaller values improve performance, but may result in out-of-order packets in a heavily congested network.

**Valid Values:**

An integer number of seconds in the range of 1 to 8.

**Default Value:**

6

**Example:**

```
LEC Config> set path-switch-delay 5
```

**reconfig-delay-min**

This parameter sets the minimum delay time when LEC returns to the initial state. This value must be  $\leq$  *reconfig-delay-max*.

**Valid Values:**

1 - the value of *reconfig-delay-max*

**Default Value:**

1

**Example:**

```
LEC Config> set reconfig-delay-min 5
```

**reconfig-delay-max**

This parameter sets the maximum delay time when LEC returns to the initial state. This value must be  $\geq$  *reconfig-delay-min*.

**Valid Values:**

1 - 10

**Default Value:**

5

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### Example:

```
LEC Config> set reconfig-delay-max 9
```

### retry-count

Sets the retry count. This is maximum number of times that the LEC retries an LE\_ARP\_REQUEST for a specific frame's LAN destination. If no ARP response is received after the specified number of retries, then the entry is purged from the LE ARP cache.

#### Valid Values:

0, 1, or 2

#### Default Value:

1

### Example:

```
LEC Config> set retry-count 2
```

### selector

Specifies the selector portion of the client's ATM address. The combination of ESI and selector must be unique among all LANE components on the device. By default, a unique selector is selected for the configured ESI.

#### Valid Values:

Any octet, in hexadecimal, that is not in use by another LANE component with the same ESI.

### Example:

```
LEC Config> set selector 01
```

**trace** Enables tracing for the LEC. To perform packet tracing, three steps are required:

1. Enable packet tracing system (under ELS)
2. Enable tracing on the LEC subsystem (under ELS)
3. Enable packet tracing on the desired LECs (using this command).

#### Valid Values:

Yes or No

#### Default Value:

No

### Example:

```
Token Ring LEC config>set trace  
Trace packets on the LEC? [No]?yes
```

### unknown-count

Sets the unknown frame count. This is the maximum number of frames for a specific unicast MAC address or route descriptor that may be sent to the BUS within the time specified by the unknown-time parameter. Larger values decrease the number of discarded frames while increasing the load on the BUS.

#### Valid Values:

An integer number of frames in the range of 1 to 255.

#### Default Value:

10

### unknown-time

Sets the unknown frame time. This is the time interval during which the maximum number of frames for a specific unicast MAC address or route



## Configuring Forum LE Clients

descriptor (specified by the unknown-count parameter) may be sent to the BUS. Larger values increase the number of discarded frames while decreasing the load on the BUS.

### Valid Values:

An integer number of seconds in the range of 1 to 60.

### Default Value:

1

### Example:

```
LEC Config> set unknown-time 5
```

### vcc-timeout

Sets the VCC timeout. Data direct VCCs over which no traffic has been sent for this period of time should be released.

**Valid Values:** 0 to 31536000 seconds (1 year).

**Default Value:** 1200

**Note:** This parameter is meaningful only for SVC connections.

### Example:

```
LEC Config> set vcc-timeout 1000
```

## Source-Routing (for Token-Ring Forum-Compliant LEC only)

Use the **source-routing** command to enable or disable end station source-routing. Source routing is the process by which end stations determine the source route to use to cross source routing bridges. Source routing allows the IP, IPX, and AppleTalk Phase 2 protocols to reach nodes on the other side of the source route bridge.

This function of the device is not changed whether source routing is enabled or disabled. The default setting is enabled.

Some stations cannot properly receive frames with Source Routing RIF on them. This is especially common among NetWare drivers. Disabling source routing in this situation will allow you to communicate with these stations.

Source routing should be enabled only if there are source-routing bridges on this ring through which you want to bridge IP, IPX, and AppleTalk Phase 2 packets. Source routing must also be enabled so that LLC test response messages can be returned.

### Syntax:

```
source-routing          enable  
                        disable
```

### Example:

```
source-routing disable
```

### LLC Configuration Commands

This section summarizes and then explains all of the LLC commands. These commands, shown in Table 49, let you monitor the LLC while passing packets over an SNA network.

Table 49. LLC Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Displays configuration information.
Set	Allows the user to dynamically configure LLC parameters that are valid for the life of the session.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

#### List

Use the **list** command to display configuration information.

**Syntax:**

**list**

#### Set

Use the **set** command to dynamically configure the LLC parameters on a current LLC session. Any changes that you make to the parameters are effective for the life of session.

**Attention:** Changing LLC parameters from the default can affect how the LLC protocol works.

**Syntax:**

**set** *n2-max\_retry count*  
*n3-frames-rcvd-before-ack count*  
*nw-acks-to-inc-ww count*  
*rw-receive-window seconds*  
*t1-reply-timer seconds*  
*t2-receive-ack-timer seconds*  
*ti-inactivity-timer seconds*  
*tw-transmit-window seconds*

**n2-max\_retry**

The maximum number of retries by LLC protocol. For example, N2 is the maximum number of times the LLC transmits an RR without receiving an acknowledgment when the inactivity timer expires. Default is 8. Minimum is 1. Maximum is 127.

**n3-frames-rcvd-before-ack**

This value is used with the T2 timer to reduce acknowledgment traffic for received I-frames. Set this counter to a specified value. Each time an

I-frame is received, this value is decremented. When this counter reaches 0 or the T2 timer expires, an acknowledgment is sent. Default is 1. Minimum is 1. Maximum is 255.

### **nw-acks-to-inc-ww**

This field is set to a default value of 1.

### **rw-receive-window**

Sets the number of I-frames that can be received before an RR is transmitted. Default is 2. Minimum is 1. Maximum is 127.

### **t1-reply-timer**

This timer expires when the LLC fails to receive a required acknowledgment or response from the other LLC station. When this timer expires, an RR is sent with the poll bit set and T1 is started again. If the LLC receives no response after the configured maximum number of retries (N2), the link underneath is declared inoperative. Default is 1. Minimum is 1. Maximum is 256.

### **t2-receive-ack-timer**

This timer is used to delay sending of an acknowledgment for a received I-format frame. This timer is started when an I-frame is received and reset when an acknowledgment is sent. If this timer expires, LLC2 sends an acknowledgment as soon as possible. Set this value so that it is less than that of T1. This insures that the remote LLC2 peer receives the delayed acknowledgment before the T1 timer expires. Default is 1 (100 ms). Minimum is 1. Maximum is 2560.

**Note:** If this timer is set to 1 (the default) it will not run (for example, **n3-frames-rcvd-before-ack=1**).

### **ti-inactivity-timer**

This timer expires when the LLC does not receive a frame for a specified time period. When this timer expires the LLC transmits an RR until the other LLC responds or the N2 timer expires. Default is 30 seconds. Minimum is 1 second. Maximum is 256 seconds.

### **tw-transmit-window**

Sets the maximum number of I-frames that can be sent before receiving an RR. Assuming that the other end of the LLC session can actually receive this many consecutive I-frames, and the device has enough heap memory to keep copies of these frames until an acknowledgment is received, increasing this value may increase the throughput. Default is 2. Minimum is 1. Maximum is 127.

---

## Accessing the LEC Monitoring Environment

Use the following procedure to access the LEC monitoring commands. This process gives you access to the LEC *monitoring* process.

1. At the OPCON prompt, enter **talk 5**. (For more detail on this command, refer to "What is the OPCON Process?" on page 31.) For example:

```
* talk 5
+
```

After you enter the **talk 5** command, the GWCON prompt (+) displays on the console. If the prompt does not appear when you first enter configuration, press **Return** again.

## Configuring LLC

- At the + prompt, enter the **network ?** command to display the network interface numbers for which the device is currently configured, and enter the *interface number* for the LEC you wish to monitor. For example:

```
+ network ?
1 : ATM Ethernet LAN Emulation: ETH
2 : IP Protocol Network
3 : Bridge Application
5 : CHARM ATM Adapter
Network number [0]? 1
LEC+
```

The LEC monitoring prompt (LEC+), is displayed.

If you know the interface number of the LEC you wish to monitor, enter the **network** command followed by the *interface number* of the LEC.

```
+ network 1
LEC+
```

---

## LEC Monitoring Commands

This section summarizes and then explains the LEC monitoring commands. You can access LEC monitoring commands at the LEC+ prompt. Table 50 shows the commands.

Table 50. LE Client Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Lists: <ul style="list-style-type: none"><li>• LEC Address Resolution Table (ARP)</li><li>• LEC configuration</li><li>• Data Direct VCC information</li><li>• Group addresses</li><li>• RIF information</li><li>• LEC statistics</li><li>• VCC table.</li></ul>
LLC	Gets you to the LLC> monitoring prompt for Token Ring LECs.
MIB	Displays LEC MIB objects including: <ul style="list-style-type: none"><li>• LEC MIB Configuration Table</li><li>• LEC MAC ARP Table</li><li>• LEC Route Descriptor Table</li><li>• LEC MIB Server VCC Tables</li><li>• LEC MIB Statistics Table</li><li>• LEC MIB Status Table</li></ul>
QoS	Gets you to the LEC x QoS+ prompt from which you can monitor Quality of Service as described in Quality of Service Monitoring Commands in <i>Using and Configuring Features</i> .
Trace	Sets packet tracing on or off or sets a trace address or trace mask.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## List

Use the **list** command to list the LEC Address Resolution Table (ART), list the LEC configuration, list Data Direct VCC information, or list LEC statistics.

### Syntax:

```
list arp-table
```

configuration  
 data-direct-vccs  
 group  
 rif  
 statistics  
 vcc-table

**arp** Lists the LEC Address Resolution Table (entries in the ARP cache).

**Example:**

LEC+ list arp

```

LEC Address Resolution (LE ARP Cache) Table
Max Table Size           = 10
Free Table Entries       = 10
Current Mac Entries      = 0
Current RD Entries       = 0
Arp Aging Time          = 300
Verify Sweep Interval    = 60

MAC Address      Remote Conn  Xmit  BUS  Arp
                  Handle  Queue Depth  Frame Count  Retry Count  Aging
                  False 652   0     0     0     60
-----
40.00.00.00.00.09 39.99.99.99.99.99.
                    99.00.00.99.99.30.02.40.00.00.00.00.09.81
  
```

**Note:** The Sweep Interval is always one-fifth of the ARP Aging Timer value.

**Max Table Size**

The total number of entries available

**Free Table Entries**

The number of free entries

**Current MAC Entries**

**Current RD Entries**

Route Descriptor ATM entries

**ARP Aging Time**

Time for an entry to be aged out

**Verify Sweep Interval**

**MAC Address**

**Remote**

**Connection Handle**

**Queue Depth**

**Xmit Frame Count**

**BUS Retry Count**

## Monitoring LE Clients

### ARP Aging Timer

### Destination ATM Address

#### configuration

Lists the LEC configuration.

For Ethernet:

#### Example:

```
IBM LEC+ list config
          ATM IBM LEC Configuration
Physical ATM interface number = 0
LEC interface number         = 7
Primary ATM address
  ESI address                 = Use burned in addr
  Selector byte               = 0x3
Emulated LAN type            = Ethernet IBM
Maximum frame size           = 1523
LE Client MAC address        = Use burned in addr
LE Server ATM address        = 00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00.00
Forward Peak Rate            = 155000
Backward Peak Rate           = 155000
MAC cache size               = 32
MAC cache aging period       = 60
Route Descriptor cache size  = 32
Route Descriptor aging period = 60
LES Registration interval     = 60
LES Registration retry count  = 3
LES keep alive count         = 10
Packet trace                  = No
IP Encapsulation             = ETHER
```

For Token Ring IBM:

#### Example:

```
IBM LEC+list config
          ATM IBM LEC Configuration
Physical ATM interface number = 0
LEC interface number         = 10
Primary ATM address
  ESI address                 = Use burned in addr
  Selector byte               = 0x6
Emulated LAN type            = Token Ring IBM
Maximum frame size           = 4551
LE Client MAC address        = Use burned in addr
LE Server ATM address        = 39.84.07.00.00.00.00.00.00.00.00.00.01.10.00.5A.DD.DA.02
Forward Peak Rate            = 155000
Backward Peak Rate           = 155000
MAC cache size               = 32
MAC cache aging period       = 60
Route Descriptor cache size  = 32
Route Descriptor aging period = 60
LES Registration interval     = 60
LES Registration retry count  = 3
LES keep alive count         = 10
Packet trace                  = No
RIF Aging Timer              = 120
Source Routing                = Enabled
```

For Token Ring Forum Compliant:

#### Example:

```
LEC+ list config
Physical ATM interface number = 0
LEC interface number         = 9
LEC ATM address              = 39.99.99.99.99.99.00.00.99.99.31.01.09.FC.DD.D0.32.70.0A
LEC MAC address               = 40.00.82.10.17.09
tecConfigMode                 = Manual
tecConfigLanType              = 802.5 - Token Ring
tecConfigMaxDataFrameSize     = 4544
tecConfigLanName              =
tecConfigLesAtmAddress        = 39.99.99.99.99.99.00.00.99.99.31.01.40.00.82.10.17.00.09
```

```

lecControlTimeout          = 30
lecMaxUnknownFrameCount    = 10
lecMaxUnknownFrameTime    = 1
lecVccTimeoutPeriod        = 1200
lecMaxRetryCount           = 1
lecAgingTime               = 300
lecForwardDelayTime        = 15
lecExpectedArpResponseTime = 1
lecFlushTimeout            = 4
lecPathSwitchingDelay      = 6
lecLocalSegmentId          = 0x0
lecMulticastSendType       = 1
lecMulticastSendAvgRate    = 365566
lecMulticastSendPeakRate   = 365566
lecConnectionCompleteTimer = 4
lecInitialControlTimeout   = 5
lecControlTimeoutMultiplier = 2
V2 Capable                 = TRUE
lecForwardDisconnectTimeout = 60
lecMinReconfigDelay        = 1
lecMaxReconfigDelay        = 5
lecMaxBusConnectRetries    = 0
lecElanId                  = 0
ExplorerExclude            = TRUE
Data direct VCC mode       = TRUE
Data direct timeout        = 20
LE ARP queue depth         = 5
LE ARP cache size          = 5000
Forward peakrate           = 365566
Backward peakrate          = 365566
Packet trace               = Off
RIF aging timer            = 120
Source Routing              = enabled

```

See “Set” on page 313 for a definition of the parameters shown in the above examples.

**data** Lists the LEC Data Direct VCC information.

**Example:**

LEC+ list data

```

LEC Data Direct VCC Table
Max Table Size = 1019 Max no of SVC connections
Current Size = 0 Currently used
Inactivity Timeout = 1200 No Data Xfer Timeout before connection is
closed (seconds)
Sweep Interval = 60
Conn Inactive User
Handle VPI VCI Timer Count Destination ATM Address
-----
652 0 7241 300 1 39.99.99.99.99.99.00.00.99.99.30.02.
40.00.00.00.00.09.81
-----

```

**group** Lists the group addresses in use by the LEC.

**rif** Lists the MAC address to Routing Information Field (RIF) mappings in use by the LEC.

**statistics**

Lists LEC statistics.

**Example:**

LEC+ list stat

```

LEC Statistics
In Octets.high = 0 No of Bytes received
In Octets.low = 346
In Discards = 2 Packets discarded
In Errors = 0 Rx.Errors
In Unknown Protos = 0 Unknown protocols received
Out Octets.high = 0 No of Bytes xmitted.
Out Octets.low = 0
Out Discards = 0
Out Errors = 0 Tx.Errors

```

## Monitoring LE Clients

```
In Frames      = 0
Out Frames     = 0
In Bytes       = 0
Out Bytes      = 0
```

### VCC table

Lists VCC table.

#### Example:

```
LEC+ list vcc
```

## LLC

Logical Link Control can be thought of as a “sub-protocol”. It is not accessed directly from either the Talk 6 (configuration) or the Talk 5 (console) environment. Instead, it is accessed from the Token Ring LEC monitoring menu by entering an **LLC** command.

Use the **llc** command to access the LLC> prompt. See “LLC Monitoring Commands” on page 335 for more information.

#### Syntax:

llc

## MIB

Use the **mib** command to display MIB objects.

**Note:** Some of this information may be displayed in a different format using the **list** command.

#### Syntax:

```
mib                _config-table
                    _mac-arp-table
                    _rd-arp-table
                    _server-vcc-table
                    _statistics-table
                    _status-table
```

**config** Displays the LEC MIB Configuration Table.

#### Example:

```
LEC+ mib config
```

```
lecConfigTable:
lecConfigMode      = Manual
lecConfigLanType   = 802.3 - Ethernet
lecConfigMaxDataFrameSize = 1516
lecConfigLanName   =
lecConfigLesAtmAddress = 39.84.0F.00.00.00.00.00.11.23.24.24.24.24.55.66.77.88.99.00
lecControlTimeout = 120
lecMaxUnknownFrameCount = 1
lecMaxUnknownFrameTime = 0
lecVccTimeoutPeriod = 1200
lecMaxRetryCount   = 1
lecAgingTime       = 300
lecForwardDelayTime = 15
lecExpectedArpResponseTime = 1
lecFlushTimeout    = 4
lecPathSwitchingDelay = 6
lecLocalSegmentId  = 0
lecMulticastSendType = 1
lecMulticastSendAvgRate = 25000000
```



```

lecMulticastSendPeakRate      = 25000000

lecConnectionCompleteTimer    = 4
lecInitialControlTimeout      = 5
lecControlTimeoutMultiplier= 2
lecConfigV2Capable            = TRUE
lecForwardDisconnectTimeout   = 60
lecMinReconfigDelay          = 1
lecMaxReconfigDelay          = 5
lecMaxBusConnectRetries      = 1
ExplorerExclude                = FALSE
Data direct VCC mode          = TRUE
Data direct timeout           = 20

```

### **lecConfigMode**

LEC config mode: AUTO or MANUAL. If AUTO, LEC Uses LECS to get the LES ATM address.

### **lecConfigLanType**

LAN type, either Ethernet or token-ring

### **lecConfigMaxDataFrameSize**

Maximum frame size

### **lecConfigLanName**

ELAN Name

### **lecConfigLesAtmAddress**

LE Server ATM address

### **lecControlTimeout**

Timeout for request/response control frame

### **lecMaxUnknownFrameCount**

Maximum number of unknown frames

### **lecMaxUnknownFrameTime**

Period in which LEC will send a maximum of MaxUnknownFrameCount frames to the BUS for a given unicast LAN Destination, and it must also initiate the address resolution protocol to resolve that LAN Destination.

### **lecVccTimeoutPeriod**

Inactivity timeout of SVC Data Direct VCCs

### **lecMaxRetryCount**

LE ARP retry count

### **lecAgingTime**

Life of unverified entry in the ARP table

### **lecForwardDelayTime**

### **lecExpectedArpResponseTime**

ARP Request/Response cycle time

### **lecFlushTimeout**

LE Flush Request/Flush Reply timeout period

### **lecPathSwitchingDelay**

### **lecLocalSegmentId**

Segment ID of emulated LAN. Only for 802.5 clients

### **lecMulticastSendType**

Signaling parameter used by LEC for multicast send VCC

## Monitoring LE Clients

### **lecMulticastSendAvgRate**

Signaling parameter used by LEC for multicast send VCC

### **lecMulticastSendPeakRate**

Signaling parameter used by LEC for multicast send VCC

### **lecConnectionCompleteTimer**

Time to wait before sending a READY\_QUERY

### **lecInitialControlTimeout**

Specifies the maximum cumulative control timeout

### **lecControlTimeoutMultiplier**

Specifies the control timeout multiplier

### **lecConfigV2Capable**

Specifies whether the LEC is LANE version 2 capable

### **lecForwardDisconnectTimeout**

Specifies the time period to wait after losing last Multicast Forward VCC

### **lecMinReconfigDelay**

Specifies the minimum delay time the LEC waits in initial state

### **lecMaxReconfigDelay**

Specifies the maximum delay time the LEC waits in initial state

### **lecMaxBusConnectRetries**

Specifies the maximum BUS connect retries before returning to initial state

### **ExplorerExclude**

Specifies whether to drop RIF explorer frames

### **Data Direct VCC Mode**

Specifies the persistent Data Direct mode

### **Data Direct Timeout**

Specifies the persistent Data Direct VCC Timeout

**mac** Displays the LEC MAC ARP Table

**rd** Displays the LEC Route Descriptor Table

**server** Displays the LEC MIB Server VCC Tables

### **Example:**

LEC+ mib server

```
lecServerVccTable:
lecConfigDirectInterface    = 0
lecConfigDirectVpi          = 0
lecConfigDirectVci          = 0
lecControlDirectInterface   = 1
lecControlDirectVpi         = 0
lecControlDirectVci         = 38
lecControlDistributeInterface = 1
lecControlDistributeVpi     = 0
lecControlDistributeVci     = 37
lecMulticastSendInterface   = 1
lecMulticastSendVpi         = 0
lecMulticastSendVci         = 34
lecMulticastForwardInterface = 1
lecMulticastForwardVpi     = 0
lecMulticastForwardVci     = 33
```

### **lecConfigDirectInterface**

The interface associated with the Configuration Direct VCC

**lecConfigDirectVpi**

VPI which identifies the above VCC if it exists

**lecConfigDirectVci**

VCI which identifies the above VCC if it exists

**lecControlDirectInterface**

The interface associated with the Control Direct VCC

**lecControlDirectVpi**

VPI which identifies the above VCC if it exists

**lecControlDirectVci**

VCI which identifies the above VCC if it exists

**lecControlDistributeInterface**

The interface associated with the Control Distribute VCC

**lecControlDistributeVpi**

VPI which identifies the above VCC if it exists

**lecControlDistributeVci**

VCI which identifies the above VCC if it exists

**lecMulticastSendInterface**

The interface associated with the Multicast Send VCC

**lecMulticastSendVpi**

VPI which identifies the above VCC if it exists

**lecMulticastSendVci**

VCI which identifies the above VCC if it exists

**lecMulticastForwardInterface**

The interface associated with the Multicast Forward VCC

**lecMulticastForwardVpi**

VPI which identifies the above VCC if it exists

**lecMulticastForwardVci**

VCI which identifies the above VCC if it exists

**statistics**

Displays the LEC MIB Statistics Table.

**Example:**

LEC+ mib statistics

```
lecStatisticsTable:
  lecArpRequestsOut      = 1
  lecArpRequestsIn      = 0
  lecArpRepliesOut      = 0
  lecArpRepliesIn       = 1
  lecControlFramesOut   = 2
  lecControlFramesIn    = 2
  lecSvcFailures        = 1
```

**lecArpRequestsOut**

No. of LE ARP requests sent by this LEC

**lecArpRequestsIn**

No. of LE ARP requests received by this LEC

**lecArpRepliesOut**

No. of LE ARP responses sent by this LEC

**lecArpRepliesIn**

No. of LE ARP responses received by this LEC

## Monitoring LE Clients

### lecControlFramesOut

No. of Control Packets sent by this LEC

### lecControlFramesIn

No. of Control Packets received by this LEC

### lecSvcFailures

The total number of:

- Outgoing LAN Emulation SVCs which this client tried but failed, to open
- Incoming LAN Emulation SVCs which this client tried, but failed to establish
- Incoming LAN Emulation SVCs which this client rejected for protocol or security reasons

**status** Lists MIB status.

#### Example:

```
LEC+ mib status
lecStatusTable:
  lecPrimaryAtmAddress = 39.84.0F.00.00.00
  Client ATM address= = 00.00.00.00.00.01.10.00.5A.00.DE.AD.03
  lecId = 1 Assigned by LES
  lecInterfaceState = Operational State of the LEC
  lecLastFailureRespCode = None Error code from last
  failed Config/Join resp.
  lecLastFailureState = Initial State State of LEC when
  updating above field.
  lecProtocol = 1 Protocol specified by
  LEC in Join requests.
  LecVersion = 1 LEC Protocol Version
  of above
  lecTopologyChange = False
  lecConfigServerAtmAddress = 00.00.00.00.00.00.
  lecConfigSource = Did not use LECS
  lecActualLanType = 802.3 - Ethernet Frame format currently
  used by LEC
  lecActualMaxDataFrameSize = 1516
  lecActualLanName = ETH Name of emulated LAN
  that LEC joined.
  lecActualLesAtmAddress = 39.84.0F.00.00.00.
  lecProxyClient = False Is LES acting like a
  proxy ?
```

## QoS Information

Use the **qos-information** command to get to the LEC x QoS+ prompt from which you can monitor Quality of Service as described in Quality of Service Monitoring Commands in *Using and Configuring Features*.

#### Syntax:

**qos-information**

## Trace

Use the **trace** command to turn packet tracing on or off on the LEC. See “Packet-trace Monitoring Commands” on page 186 for more information.

Use the **trace mac-address** command to limit the data traced. A packet will only be traced if its destination or source MAC address logically ANDed with the trace MAC mask equals the trace MAC address logically ANDed with the trace MAC mask.

#### Syntax:

**trace**

## LLC Monitoring Commands

This section summarizes and then explains all of the LLC commands. These commands, shown in Table 51, let you monitor the LLC while passing packets over an SNA network.

Table 51. LLC Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Displays configuration information.
Set	Allows the user to dynamically configure LLC parameters that are valid for the life of the session.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### List

Use the **list** command to display configuration information.

#### Syntax:

**list**

### Set

Use the **set** command to dynamically configure the LLC parameters on a current LLC session. Any changes that you make to the parameters are effective for the life of session.

**Attention:** Changing LLC parameters from the default can affect how the LLC protocol works.

#### Syntax:

**set** *n2-max\_retry count*  
*n3-frames-rcvd-before-ack count*  
*nw-acks-to-inc-ww count*  
*t1-reply-timer seconds*  
*t2-receive-ack-timer seconds*  
*ti-inactivity-timer seconds*  
*tw-transmit-window seconds*

#### **n2-max\_retry**

The maximum number of retries by LLC protocol. For example, N2 is the maximum number of times the LLC transmits an RR without receiving an acknowledgment when the inactivity timer expires. Default is 8. Minimum is 1. Maximum is 127.

#### **n3-frames-rcvd-before-ack**

This value is used with the T2 timer to reduce acknowledgment traffic for received I-frames. Set this counter to a specified value. Each time an I-frame is received, this value is decremented. When this counter reaches 0 or the T2 timer expires, an acknowledgment is sent. Default is 1. Minimum is 1. Maximum is 255.

## Monitoring LLC

### **nw-acks-to-inc-ww**

This field is set to a default value of 1.

### **t1-reply-timer**

This timer expires when the LLC fails to receive a required acknowledgment or response from the other LLC station. When this timer expires, an RR is sent with the poll bit set and T1 is started again. If the LLC receives no response after the configured maximum number of retries (N2), the link underneath is declared inoperative. Default is 1. Minimum is 1. Maximum is 256.

### **t2-receive-ack-timer**

This timer is used to delay sending of an acknowledgment for a received I-format frame. This timer is started when an I-frame is received and reset when an acknowledgment is sent. If this timer expires, LLC2 sends an acknowledgment as soon as possible. Set this value so that it is less than that of T1. This insures that the remote LLC2 peer receives the delayed acknowledgment before the T1 timer expires. Default is 1 (100 ms). Minimum is 1. Maximum is 2560.

**Note:** If this timer is set to 1 (the default) it will not run (for example, **n3-frames-rcvd-before-ack=1**).

### **ti-inactivity-timer**

This timer expires when the LLC does not receive a frame for a specified time period. When this timer expires the LLC transmits an RR until the other LLC responds or the N2 timer expires. Default is 30 seconds. Minimum is 1 second. Maximum is 256 seconds.

### **tw-transmit-window**

Sets the maximum number of I-frames that can be sent before receiving an RR. Assuming that the other end of the LLC session can actually receive this many consecutive I-frames, and the device has enough heap memory to keep copies of these frames until an acknowledgment is received, increasing this value may increase the throughput. Default is 2. Minimum is 1. Maximum is 127.

---

## LEC Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### **CONFIG (Talk 6) Delete Interface**

LAN Emulation Client (LEC) supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

### **GWCON (Talk 5) Activate Interface**

LEC supports the GWCON (Talk 5) **activate interface** command with no restrictions.

All LEC interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

### **GWCON (Talk 5) Reset Interface**

LEC supports the GWCON (Talk 5) **reset interface** command with no restrictions.

| All LEC interface-specific commands are supported by the GWCON (Talk 5) **reset**  
| **interface** command.

## | **GWCON (Talk 5) Temporary Change Commands**

| LEC supports all the GWCON commands that temporarily change the operational  
| state of the device. These changes are lost whenever the device is reloaded,  
| restarted, or you execute any dynamically reconfigurable command.

| All LEC modifications in Talk 5 affect an immediate operational change.





---

## Chapter 28. Using Channel Adapters

This chapter describes how to plan for host definition and 2216 ESCON and Parallel Channel Adapter (PCA) support. It includes the following sections:

- “Host Definition Planning”, provides information to help you plan for host definition.
- “Planning for 2216 Support” on page 358, describes considerations for support of the 2216 and channel adapters in a network.
- “Channel Adapter Overview” on page 359, describes channel adapter support:
  - LCS (LAN Channel Station) over which you can run TCP/IP
  - LSA (Link Services Architecture) over which you can run hierarchical SNA, including DLSw, APPN ISR, or APPN HPR
  - MPC+ (Multi-Path Channel) over which you can run APPN HPR, TCP/IP, and HPDT UDP (UDP+)

**Note:** UDP+ is not supported on a Parallel Channel Adapter (PCA).

- “Configuring the Channel Adapter Interface” on page 377
- “Channel Adapter Configuration Commands” on page 380

---

### Host Definition Planning

This section provides information to help you plan for host definition. It includes information for system definition from the host perspective and information for definition from the 2216 perspective.

Before you can attach the 2216 to a channel, the host system must be configured correctly. The following series of steps is required to define the 2216 connection to the host. These definition steps should be done by your system programmer.

1. Define the 2216 to the host channel subsystem using either the host Input/Output Configuration Program (IOCP) or Hardware Configuration Definition (HCD) program.
2. Define the 2216 as a control unit to the host operating system.
3. Define the 2216 and configuration to the host program (TCP/IP or VTAM).

After the host definitions are complete, you must configure the 2216 channel interfaces using the command line interface, or using the configuration program described in *Configuration Program User's Guide for Nways Multiprotocol and Access Services*, GC30-3830. Many of the parameters which you provide when you configure the 2216 must match corresponding parameters in the host definition.

Finally, the stations will need to be configured to communicate through the 2216 to the host applications.

The following sections describe host definition and provide sample host configuration statements.

### IOCP Definition for the 2216

The following sections describe examples of IOCP definitions for the 2216 with channel adapters. The output of the IOCP device definitions (I/O Configuration Data Set or IOCDS) can be generated using MVS, VM, VSE, or in a stand-alone environment. Refer to the *IBM ES/9000 and ES/3090 Input/Output Configuration Program User's Guide Volume A04*, GC38-0097, for details.

## Example IOCP Definition for the ESCON Channel

Figure 19 shows an example of an ESCON configuration. The S/390 host is divided into two logical partitions (LP): LPA and LPB. A connection on path 30 is configured between LPA and 2216A through ESCD switch 00. LPA is attached to ESCD port C0 and 2216A is attached to port C1. The connection between port C0 and C1 is dynamic.

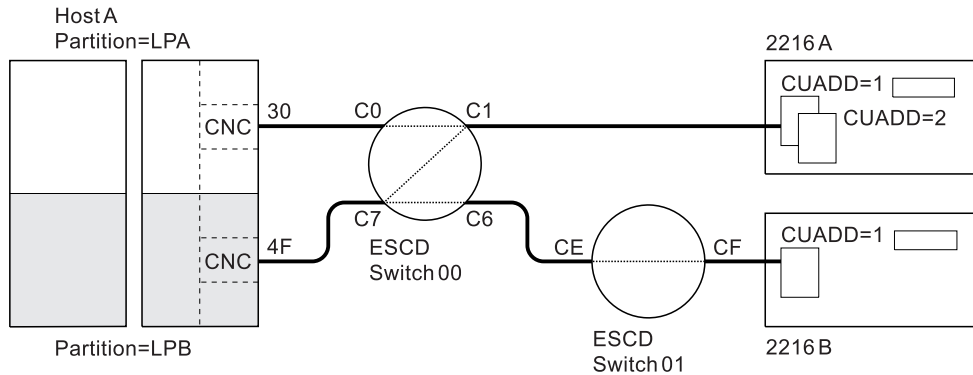


Figure 19. ESCON Channel Configuration Example

LPB on path 4F has a connection with 2216A through ESCD switch 00, and a connection with 2216B through ESCD switches 00 and 01. The connection between ports C7 and C6 is dynamic; the connection between ESCD ports CE and CF is dedicated.

The following example definitions match Figure 19:

Channel path definitions:

```
CHPID    PATH=((30)),TYPE=CNC,PART=(LPA),SWITCH=00
CHPID    PATH=((4F)),TYPE=CNC,PART=(LPB),SWITCH=00
```

Control unit and device definition for the 2216, with logical addressing = 1 for 2216A:

```
CNTLUNIT  CUNUMBR=500,PATH=30,UNIT=3172,LINK=C1,      X
           UNITADD=(00,32),CUADD=1
IODEVICE  ADDRESS=(500,32),CUNUMBR=500,UNIT=3172,    X
           UNITADD=00
```

Control unit and device definition for the 2216 with logical addressing = 2 for 2216A:

```
CNTLUNIT  CUNUMBR=600,PATH=4F,UNIT=3172,LINK=C1,      X
           UNITADD=(00,32),CUADD=2
IODEVICE  ADDRESS=(600,32),CUNUMBR=600,UNIT=3172,    X
           UNITADD=00
```

Control unit and device definition for the 2216, with logical addressing = 1 for 2216B:

```
CNTLUNIT  CUNUMBR=620,PATH=4F,UNIT=3172,LINK=C6,      X
           UNITADD=(20,32),CUADD=1
IODEVICE  ADDRESS=(620,32),CUNUMBR=620,UNIT=3172,    X
           UNITADD=20
```

The IOCP macroinstructions in the example:

- Assign a CHPID to logical partitions LPA and LPB.
- Define channel path 30 to the 2216 for partition LPA and channel path 4F for partition LPB.
- Identify channel type as an ESCON channel (CNC).
- Assign the two CHPIDs to ESCD switch number 00.

- Associate control unit numbers 500 and 600 to logical addresses 1 and 2 on 2216A and control unit number 620 to logical address 1 on 2216B.
- Assign link address C1 to control units 500 and 600 and link address C6 to control unit 620.
- Define unit addresses (subchannels) 00 through 1F to control units 500 and 600 and unit addresses 20 through 3F to control unit 620.
- Identify each control unit as a 3172 device.

**Considerations:**

1. The allowable device address range is 00 through FF. The 2216 address range is limited to 64 addresses, and only requires that the addresses defined at the host computer map to the address or addresses configured in the 2216. The address range can extend beyond the addresses actually used, but cannot overlap addresses of other control units cabled to the same CHPID or channel.
2. The ESCON channel mode of operation can be type CNC for basic ESCON channel mode or CVC if there is an ESCON Converter attached.
3. The IODEVICE UNIT parameter should be set to 3172.
4. The LINK number specifies the link address (ESCD port number) to which the 2216 is connected. When two ESCDs are connected in series, the link address must be the port number of the ESCD that has the dynamic connection and to which the 2216 is attached.

**Example IOCP Definition for the EMIF Host**

Figure 20 shows an example of an ESCON configuration using the ESCON Multiple Image Facility (EMIF). The S/390 host is divided into two logical partitions (LP): LPA and LPB. Both LPA and LPB are connected on path 30 to 2216 A through switch 00.

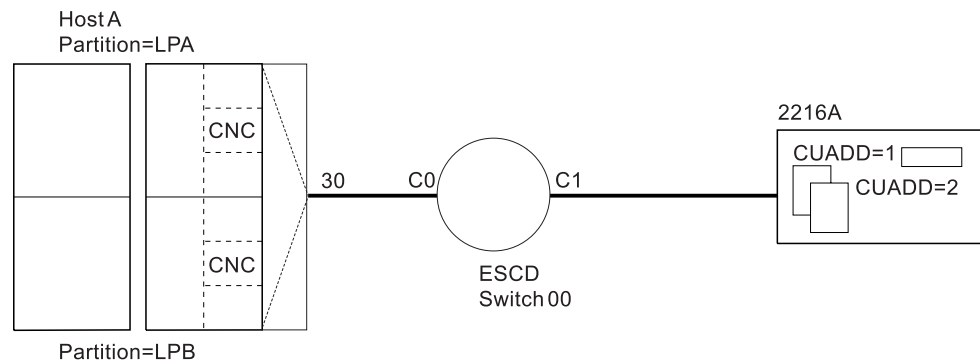


Figure 20. EMIF Host Configuration Example

The following example definitions match Figure 20:

Channel path definitions:

```
CHPID      PATH=((30)),TYPE=CNC,PART=(LPA,LPB),SWITCH=00
```

Control unit and device definition for the 2216, with logical addressing = 1 for 2216A:

```
CNTLUNIT   CUNUMBR=500,PATH=30,UNIT=3172,LINK=C1,          X
            UNITADD=(00,32),CUADD=1
IODEVICE   ADDRESS=(500,32),CUNUMBR=500,UNIT=3172,        X
            UNITADD=00
```

Control unit and device definition for the 2216, with logical addressing = 2 for 2216A:

CNTLUNIT	CUNUMBR=620,PATH=30,UNIT=3172,LINK=C1, UNITADD=(20,32),CUADD=2	X
IODEVICE	ADDRESS=(620,32),CUNUMBR=620,UNIT=3172, UNITADD=20	X

The IOCP macroinstructions in the example:

- Assign a CHPID to logical partitions LPA and LPB
- Define channel path 30 to the 2216 to be shared by partition LPA and partition LPB.
- Identify channel type as an ESCON channel (CNC)
- Assign the CHPID to ESCD switch number 00
- Associate control unit numbers 500 to logical address 1 and 620 to logical address 2 on 2216A
- Assign link address C1 to control units 500 and 620
- Define unit addresses (subchannels) 00 through 1F to control unit 500 and 20 through 3F to control unit 620
- Identify each control unit as a 3172 device.

**Considerations:**

1. The allowable device address range is 00 through FF. The 2216 address range is limited to 64 addresses, and only requires that the addresses defined at the host computer map to the address or addresses configured in the 2216. The address range can extend beyond the addresses actually used for the 2216, but cannot overlap addresses of other control units cabled to the same CHPID or channel.
2. The ESCON channel mode of operation can be type CNC for basic ESCON channel mode or CVC if there is an ESCON Converter attached.
3. The IODEVICE UNIT parameter should be set to 3172.
4. The LINK number specifies the link address (ESCD port number) to which the 2216 is connected. When two ESCDs are connected in series, the link address must be the port number of the ESCD that has the dynamic connection and to which the 2216 is attached.

**Example IOCP Definition for the Parallel Channel Adapter (PCA)**

Figure 21 on page 343 shows an example of a simple Parallel Channel Adapter configuration where the channel type is identified as a block multiplexer channel, TYPE=BL, on path 5.

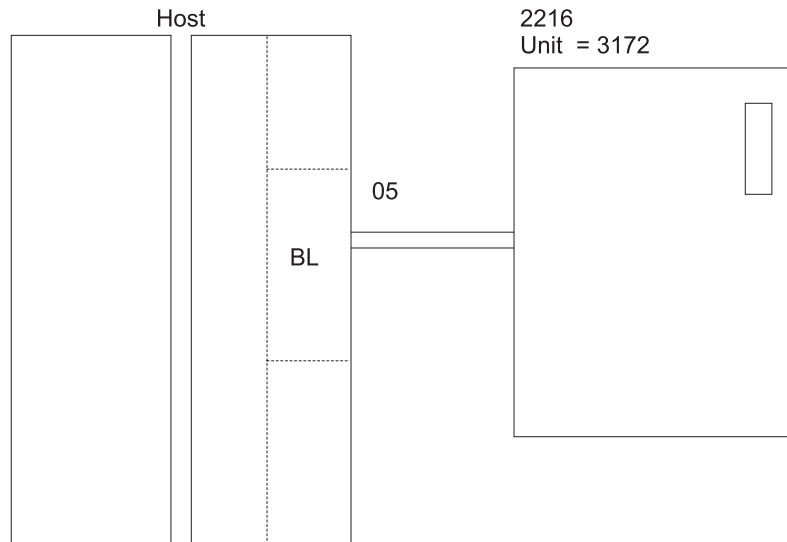


Figure 21. Parallel Channel Adapter Configuration Example

The IBM 2216 I/O device unit appears to the host as 3172 and must be defined as a 3172.

The following example definitions match Figure 21:

```

CHPID      PATH=((05)),TYPE=BL
CNTLUNIT   CUNUMBR=640,PATH=05,
           PROTOCL=S4,UNIT=3172,
           SHARED=N,UNITADD=((40,32))
IODEVICE   UNIT=3172,ADDRESS=((640,32)),
           STADET=N,CUNUMBER=640,TIMEOUT=Y

```

The IOCP macroinstructions in the example:

- Identify channel type as a block multiplexer channel (BL).
- Name channel path 05 to which the PCA is attached.
- Assign the control unit number 640 to the PCA.
- Specify that the host channel supports up to 4.5 MB data-streaming (S4).
- Identify the control unit as type 2 where multiple I/O request are supported concurrently (SHARED=N).
- Define unit addresses 40 through 5F to the PCA (a range of 32 addresses).
- Identify the PCA control unit as a 3172-type device.

**Considerations:**

1. The address range for each PCA must be contiguous pairs of addresses for TCP/IP, a single address for VTAM and at least one read subchannel and one write subchannel for MPC+.

The allowable device address range is 00 through FF. Each 2216 PCA can support a maximum of 32 subchannels. The 2216 PCA does not require a range of 32 addresses, it only requires that the addresses defined at the host computer map to the address or addresses configured for the 2216 PCA. The addresses used cannot overlap addresses used by other control units or PCAs cabled to the same CHPID or channel.

2. The PROTOCL parameter can be set to the following values, depending on your host system capability:

**D** Direct-Coupled Interlock (DCI) mode

- S** Maximum 3.0 MBps data streaming speed
- S4** Maximum 4.5 MBps data streaming speed

The transfer mode and channel transfer speed specified for the PROTOCL parameter must conform with the PCA setting for transfer mode and channel transfer speed.

3. The UNIT parameter on the CNTLUNIT and IODEVICE statements must be set to 3172.
4. When an ESCON Converter is the channel path, the CHPID TYPE parameter must be set to FX, otherwise it is set to BL.

## Defining the 2216 to the Operating System

The following definitions apply to a 2216 with a channel adapter.

### 2216 Definition for VM/SP

The 2216 must be defined to a VM/SP operating system. This definition is accomplished by updating the real I/O configuration file (DMKRIO) with entries for the 2216 in the RDEVICE and the RCTLUNIT macros. In the following example, 640 is the base unit address and the size of the address range is 32.

```
RDEVICE ADDRESS=(640,32),DEVTYPE=3088
RCTLUNIT ADDRESS=640,CUTYPE=3088,FEATURE=32-DEVICE
```

### 2216 Definition for VM/XA and VM/ESA

The 2216 must be defined to a VM/Extended Architecture (VM/XA or VM/ESA) operating system. This definition is accomplished by updating the real I/O configuration file (HCPRIO) with an entry for the 2216 in the RDEVICE macro. In the following examples, 640 and 2A0 are base control unit addresses. The address range size, as defined in the UCW or IOCP, is 8 in both examples.

The following example is a VM/XA HCPRIO definition:

```
RDEVICE ADDRESS=(640,8),DEVTYPE=CTCA
```

The following example is a VM/ESA HCPRIO definition:

```
RDEVICE ADDRESS=(2A0,8),DEVTYPE=CTCA
```

### 2216 Definition for MVS/XA and MVS/ESA without HCD

**Note:** To define a 2216 on an MVS/ESA system with HCD, see “2216 Definition for MVS/ESA with HCD” on page 345

The 2216 must be defined to an IBM Multiple Virtual Storage/Extended Architecture (MVS/XA) or MVS/ESA operating system. This definition is accomplished by updating the MVS Control Program with an entry for the 2216 in the IODEVICE macro.

For ESCON channels, an example IODEVICE macro is:

```
IODEVICE UNIT=3172,ADDRESS(540,8)
```

For parallel channels, an example IODEVICE macro is:

```
IODEVICE UNIT=CTC,ADDRESS(640,8)
```

The base control unit addresses are 640 and 540. The address range size, as defined in the UCW or IOCP, is 8 in both examples.

## 2216 Definition for MVS/ESA with HCD

The hardware configuration definition (HCD) component of MVS/ESA SP Version 4.2 and 4.3 with APAR #OY67361 offers an improved method of defining system hardware configuration for 2216. Several complex steps required for entering hardware configuration data can be accomplished using an interactive dialog with HCD.

The required configuration data for the 2216 is:

1. When using HCD, with APAR #OY67361, the 2216 is defined as (UNIT=3172).

```
IODEVICE UNIT=3172,ADDRESS(740,8)
```

2. Without HCD, the 2216 is defined for:

- Parallel channels as a 3088 device (UNIT = 3088 or CTC)

```
IODEVICE UNIT=CTC,ADDRESS(840,8)
```

- ESCON channels as a serial CTC device (UNIT = SCTC)

```
IODEVICE UNIT=SCTC,ADDRESS(A40,8)
```

### Notes:

1. If you are using HCD for MVS Version 4 to define your ESCON host connection, you will need APAR #OY67361 to obtain the UIM support for the device definition (UNIT=3172).
2. When migrating your IOCP definition and operating system definitions to the HCD environment, it is important that all 2216 device statements be changed to device type (UNIT=3172).

## 2216 Definition for VSE/ESA

The 2216 must be defined to a VSE/ESA operating system. This definition is accomplished by supplying an ADD statement for each channel unit address at initial program load (IPL) time. Code the device type on the ADD statement as CTCA,EML as shown in the following example:

```
ADD 640,CTCA,EML
```

The base control unit address is 640 in the example. For the number of channel unit addresses added, increment the IOTAB storage macro by this count.

## Defining the 2216 to Host Programs

The section has configuration definitions with samples of host definitions required to connect to the 2216 channel adapter.

### Configuring the Host for TCP/IP

TCP/IP can connect to the 2216 channel adapter using either LCS or MPC+. When using MPC+, TCP/IP in the host goes through VTAM to the 2216.

**Note:** When referring to MPC+, the host uses the term HPDT MPC while the 2216 uses the term MPC+.

TCP is configured on a host by modifying the TCP/IP profile. The default name for the TCP/IP profile data set is TCPIP.PROFILE.TCPIP for MVS and PROFILE TCPIP for VM. Each channel connection requires:

- A DEVICE statement for each subchannel pair or group.
- A LINK statement for each LCS interface on the 2216. Multiple LINKs can be defined for a single DEVICE.
- A LINK statement for each IP address supported over an MPC+ Group. Only one LINK can be defined for a single DEVICE.
- An entry in the HOME statement for each LINK statement.

- Entries in the GATEWAY statement for the link to be used (if ROUTED is not being used)
- A START command for each device

See the OS/390 TCP/IP OpenEdition publications for more information on configuring TCP/IP.

**Configuring the Host for TCP/IP using LCS:** These are the statements required to configure TCP/IP on the host when using LCS:

**DEVICE and LINK statements:** The format of the DEVICE and LINK statements are:

```
DEVICE devicename LCS subchannel
LINK iplinkname LANtype LANnumber devicename
```

where:

**devicename**

is a local name to distinguish devices. You need a START statement for this device name at the end of the TCP/IP profile as shown in “Example of TCP/IP Commands when Using LCS” on page 347.

**LCS subchannel**

is the even subchannel of the two LCS subchannels that this connection to the 2216 will use.

**iplinkname**

is a local name to distinguish links. This name can help you identify which link is being configured.

**LANtype**

is the type of link.

**LANnumber**

is obtained from the 2216 by using the LIST NETS command of the appropriate NETWORK submenu.

**HOME Command:** Specify IP addresses for each channel connection using the following format:

```
HOME hostipadd iplinkname
```

where:

**hostipadd**

is the host’s IP address for this connection to the TCP/IP network.

**Note:** This IP address must be a unique address in the same IP subnetwork as the corresponding IP address coded in the 2216.

**iplinkname**

is the link name defined by the LINK statement as described in “DEVICE and LINK statements”.

**GATEWAY Command:** Specify routing information if you are not using the ROUTED server.

```
GATEWAY network first hop driver packet size subn mask subn value
```

where:



**network**

is the IP address for the network. The default value is DEFAULTNET, which specifies a default routing entry for any network not explicitly routed.

**first hop**

Specify one of the following:

An equal sign (=) meaning that messages are routed directly to destinations on that network or directly to that host. This is not supported for DEFAULTNET.

The Internet address of a gateway or router that you can reach directly, and that forwards messages for the destination network or host.

**driver** is the *iplinkname* defined by the LINK statement as described in “DEVICE and LINK statements” on page 346.

**packet size**

is the maximum transmission unit in bytes for the network or host.

**subn mask**

is a bit mask that defines the bits of the host field that make up the subnet field.

**subn value**

is the value of the subnet field.

*START Command:* Start all the interfaces:

```
START devicename
```

where:

**devicename**

is the parameter defined by the DEVICE statement as described in “DEVICE and LINK statements” on page 346.

**Example of TCP/IP Commands when Using LCS:**

```
DEVICE LCS1 LCS 108
LINK TR1 IBMTR 0 LCS1
HOME
    16.51.136.199 TR1 1
GATEWAY
    16.51.136.201 = TR1 4000 HOST 2
    DEFAULTNET 16.51.136.201 TR1 4000 0
START LCS1
```

**1** 16.51.136.199 is in the same IP subnetwork as the 2216 LCS interface’s IP address.

**2** 16.51.136.201 is the 2216 LCS interface’s IP address.

**Configuring the Host for TCP/IP using MPC+:** These are the statements required to configure TCP/IP on the host when using MPC+:

*DEVICE and LINK statements:*

```
DEVICE devicename MPCPTP
LINK iplinkname MPCPTP devicename
```

where:

**devicename**

is the name of the TRL that this connection to the 2216 will use. See “Sample 2216 Definition to TCP/IP for MVS or VM for MPC+” on page 350 for additional information.

## **MPCPTP**

specifies an MPC point-to-point link.

### **iplinkname**

is a link name to distinguish links. This name can help you identify which link is being configured.

*HOME Command:* Specify IP addresses for each channel connection using the following format:

```
HOME hostipadd iplinkname
```

where:

### **hostipadd**

is the host's IP address for this connection to the TCP/IP network.

**Note:** This IP address must be a unique address in the same IP subnetwork as the corresponding IP address coded in the 2216.

### **iplinkname**

is the link name defined by the LINK statement as described in "DEVICE and LINK statements" on page 347.

*GATEWAY Command:* Specify routing information if you are not using the ROUTED server.

```
GATEWAY network first hop driver packet size subn mask subn value
```

where:

### **network**

is the IP address for the network. The default value is *defaultnet*, which specifies a default routing entry for any network not explicitly routed.

### **first hop**

Specify one of the following:

An equal sign (=) meaning that messages are routed directly to destinations on that network or directly to that host. This is not supported for DEFAULTNET.

The Internet address of a gateway or router that you can reach directly, and that forwards messages for the destination network or host.

**driver** is the *iplinkname* defined by the LINK statement as described in "DEVICE and LINK statements" on page 347.

### **packet size**

is the maximum transmission unit in bytes for the network or host.

### **subn mask**

is a bit mask that defines the bits of the host field that make up the subnet field.

### **subn value**

is the value of the subnet field.

*START Command:* Start all the interfaces:

```
START devicename
```

where:

### devicename

is the parameter defined by the DEVICE statement as described in "DEVICE and LINK statements" on page 347.

### Example of TCP/IP Commands when Using MPC+: For MPC+:

```
DEVICE IPTRL1 MPCPTP
LINK LINK1 MPCPTP IPTRL1
HOME
  198.10.70.199 LINK1 1
GATEWAY
  198.10.70.203 = LINK1 16000 HOST 2
  DEFAULTNET 198.10.70.203 LINK1
START IPTRL1
```

**1** 198.10.70.199 is in the same IP subnetwork as one of the 2216 MPC+ interface's IP addresses.

**2** 198.10.70.203 is one of the 2216 MPC+ interface's IP addresses.

### Sample 2216 Definition to TCP/IP for MVS or VM for LCS

The following is an example of TCP/IP definitions that would be provided to the host computer in the TCP/IP Profile data set to configure an LCS device. The default name for the TCP/IP profile data set is TCPIP.PROFILE.TCPIP for MVS and PROFILE TCPIP for VM.

First, 2216 devices and links are defined to TCP/IP.

There is a DEVICE statement for each subchannel pair that is used to access 2216s. The first address specified must be an *even* address. In this example, two devices (subchannel pairs) are defined: one at address 640 and one at address 642. These devices could be in the same or different 2216s. A device type of LCS (LAN Channel Station) is used to define these devices to TCP/IP.

There is a LINK statement for each LAN adapter that is accessible from these devices. In this example, one Ethernet/802.3 Adapter is assigned to the device using subchannels 640 and 641, two Token-Ring adapters are assigned to the device using 642 and 643, and one FDDI adapter using 644 and 645. These two Token-Ring adapters are in the same 2216 because they are associated with the same device. The LINK number for each adapter (0 and 1 in this example) is assigned by the 2216 when you add an adapter to a profile.

**Note:** Two subchannel addresses are required for sending and receiving (for example, 640 and 641), but only the first address is defined.

```
DEVICE LCS1 LCS 640
LINK ETH1 ETHERor802.3 0 LCS1
DEVICE LCS2 LCS 642
LINK TR1 IBMTR 0 LCS2
LINK TR2 IBMTR 1 LCS2
DEVICE LCS3 LCS 644
LINK FD1 FDDI 0 LCS3
```

**Note:** In this example, 0 and 1 are the LAN numbers for these connections.

This section of the example TCP/IP profile defines the local host internet addresses:

```
HOME
  193.5.2.1 ETH1
  130.50.75.1 TR1
  130.50.76.1 TR2
  195.10.70.1 FD1
```

This section of the example TCP/IP profile represents the LAN/WAN gateway definition:

#### GATEWAY

Network	First hop	Driver	Packet Size	Subnet mask	Subnet value
193.5.2	=	ETH1	1500	0	
130.50	=	TR1	2000	0.0.255.0	0.0.75.0
130.50	=	TR2	2000	0.0.255.0	0.0.76.0
195.10	=	FD1	4000	0.0.255.0	0.0.70.0

This section of the example TCP/IP profile activates the LCS devices:

```
START LCS1
START LCS2
START LCS3
```

The following examples illustrate various ways that LAN adapters can be specified and linked to subchannel pairs in the TCP/IP profile.

Two LCS devices for the two subchannel pairs 40,41 and 42,43 and four LAN adapters are defined in the 2216 as follows:

```
DEVICE LCS1 LCS 640
LINK ETH1 ETHERNET 0 LCS1
LINK ETH2 ETHERNET 1 LCS1
DEVICE LCS2 LCS 642
LINK TRN1 IBMTR 0 LCS2
LINK TRN2 IBMTR 1 LCS2
```

Four LCS devices for the four subchannel pairs 40,41; 42,43; 44,45; and 46,47 and four LAN adapters are defined in the 2216 as follows:

```
DEVICE LCS1 LCS 640
LINK ETH1 ETHERNET 0 LCS1
DEVICE LCS2 LCS 642
LINK ETH2 ETHERNET 1 LCS2
DEVICE LCS3 LCS 644
LINK TRN1 IBMTR 0 LCS3
DEVICE LCS4 LCS 646
LINK FD1 FDDI 0 LCS4
```

One LCS device for the subchannel pair 40,41 and four LAN adapters are defined in the 2216 as follows:

```
DEVICE LCS1 LCS 640
LINK ETH1 ETHERNET 0 LCS1
LINK ETH2 ETHERNET 1 LCS1
LINK ETH3 ETHERNET 2 LCS1
LINK ETH4 ETHERNET 3 LCS1
```

### Sample 2216 Definition to TCP/IP for MVS or VM for MPC+

The following is an example of TCP/IP definitions that would be provided to the host computer in the TCP/IP Profile data set to configure an MPC+ device. The default name for the TCP/IP profile data set is TCPIP.PROFILE.TCPIP for MVS and PROFILE TCPIP for VM.

First, in the VTAM host, define a TRL over which TCP/IP should run.

```
IPTRL VBUILD TYPE=TRL
IPTRL1 TRLE LNCTL=MPC,
      MAXBFRT=6,
      READ=(06),
      WRITE=(07)
      REPLYTO=3.0
```

#### Notes:

1. Multiple TCP/IP stacks can use the same TRL.
2. See "Configuring the VTAM Host for MPC+ for IP" on page 357 for more details.

There is a DEVICE statement for each TRL that is to be used by TCP/IP.

```
DEVICE IPTRL1 MPCPTP
```

There is a LINK statement for each TCP/IP local host internet address using the TRL. For a given TCP/IP stack, there can only be one LINK statement per TRL.

```
LINK LINK1 MPCPTP IPTRL1
```

This section of the example TCP/IP profile defines the local host internet addresses and associates the addresses with a link:

```
HOME
198.10.70.199 LINK1 1
```

**1** 198.10.70.199 is in the same IP subnetwork as one of the 2216 MPC+ interface's IP addresses.

This section of the example TCP/IP profile represents the LAN/WAN gateway definition:

```
GATEWAY
Network      First hop      Driver  Packet Size  Subnet mask  Subnet value
198.10.70.203 =          LINK1   16000        HOST        1
DEFAULTNET   198.10.70.203 LINK1   16000        0
```

**1** 198.10.70.203 is one of the 2216 MPC+ interface's IP addresses.

This section of the example TCP/IP profile activates the MPC+ device:

```
START IPTRL1
```

**Note:** Prior to activating the device, activate the associated TRL if it is not already active.

## Configuring the Host for HPDT UDP:

### Important!

Before you configure your S/390 host for HPDT UDP, you **must** have APAR #OW31305 installed.

HPDT UDP can connect to the 2216 only through an ESCON Channel Adapter using MPC+.

### Notes:

1. The 2216 refers to HPDT UDP as UDP+.
2. UDP+ is not supported on a Parallel Channel Adapter (PCA).

HPDT UDP is configured and run using OS/390 TCP/IP OpenEdition (OE) on the host. Therefore, OS/390 TCP/IP OpenEdition must be installed on the host.

HPDT UDP commands are used to configure and control HPDT UDP resources. See *IBM OS/390 TCP/IP Update Guide* for details on installing and using OE for HPDT UDP.

To configure and activate an HPDT UDP connection on the 2216, issue the **oeifconfig** command, shown in the following example.

```
oeifconfig interface_name source_IP_address destination_IP address mtu nnnn
```

where:

### **interface\_name**

is the name of the TRL for the HPDT UDP connection.

This will cause the TRL to be activated if it is not already active.

**Note:** See “Configuring the VTAM Host for MPC+ for IP” on page 357 for information about TRLs.

**source\_IP\_address**

is the local IP address in the host for HPDT UDP connection.

This local IP address must be in the same IP subnetwork as the IP address coded for the UDP+ MPC+ network handler in the 2216.

**destination\_IP\_address**

is the destination IP address in the 2216 for this HPDT UDP connection.

This destination IP address must equal the IP address coded on the UDP+ MPC+ network handler in the 2216.

**mtu nnnn**

where nnnn is the maximum transmission unit size for the HPDT UDP connection.

This mtu size must be equal to Maxdata coded on the UDP+ MPC+ network handler in the 2216. If the values are not equal, then the HPDT UDP connection will not come up.

**Note:** Because this is a point-to-point connection, there is no need to code the netmask parameter on this command.

**Sample 2216 Definition to HPDT UDP for MVS or VM**

First, in the VTAM host, define a TRL over which HPDT UDP should run.

```
UDPTL VBUILD TYPE=TRL
TRL1  TRLE LNCTL=MPC,
      MAXBFRU=9,
      READ=(EA0),
      WRITE=(EA1),
      REPLYTO=3.0
```

**Note:** See “Configuring the VTAM Host for MPC+ for IP” on page 357 for more details.

Next, go to the OE environment and issue the following command:

```
oeifconfig trl1 198.10.60.199 198.10.60.203 mtu 16384
```

**VTAM Control Blocks Used to Configure LSA at the Host**

Configuring the VM or MVS host requires entries in two VTAM control blocks:

- External communication adapter (XCA) major node definition file
- Switched major node configuration file

For more information on configuring VTAM, refer to *IBM VTAM Resource Definition Reference*.

**XCA Major Node Definition File - Sample:** Defining an XCA major node requires coding VTAM definition statements to define the following characteristics:

- Node type (VBUILD definition statement)
- Port used by the LAN (PORT definition statement)
- Switched lines attached through the 2216 channel adapter (GROUP, LINE, and PU definition statements)

You must code a VBUILD definition statement and a PORT definition statement for the major node, and code GROUP, LINE, and PU definition statements for minor nodes.

You must also assign service access points (SAPs) to be used for each virtual channel to a LAN or emulated LAN.

**Switched Major Node Definition File - Sample:** The switched major node definition file defines the workstations that VTAM will be able to access through the 2216 channel adapter, and identifies:

- Node type (VBUILD definition statement)
- Network Resources (PU and LU definition statements)

To define the 2216 LAN/WAN gateway to VTAM, the appropriate LAN adapter in the IBM 2216 must be associated with a subchannel address. This association is defined to VTAM in a major node definition that is supported by VTAM Version 3 Release 4 and VTAM Version 4 Release 1.

### Configuring an LSA Direct Connection at the VTAM Host

Configuring the VM or MVS host requires entries in two VTAM control blocks, the XCA Major Node Definition File and the Switched Major Node Definition File. See "VTAM Control Blocks Used to Configure LSA at the Host" on page 352 for a description of the purpose of these control blocks and references to VTAM publications

#### XCA Major Node Definition File - Sample:

```
ROUTE6B1 VBUILD TYPE=XCA
PORT6B1 PORT CUADDR=0CB,ADAPNO=0,TIMER=60,SAPADDR=08, C
          MEDIUM=RING
GRP6B1 GROUP DIAL=YES
*****
LN06B001 LINE ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU06B001 PU ISTATUS=ACTIVE
```

#### Notes:

1. ADAPNO is the LAN number for the 2216 LSA interface.
2. CUADDR is the channel address. This corresponds to the Device Address (three hexadecimal characters defining the channel address) for the 2216 LSA interface.
3. MEDIUM=RING for Token Ring, MEDIUM=CSMACD for Ethernet, and MEDIUM=FDDI for FDDI. This corresponds to the value specified for LANtype for the 2216 interface.

#### Switched Major Node Definition File - Sample:

```
PS06SW VBUILD TYPE=SWNET
PS06PU PU ADDR=01,IDBLK=05D,IDNUM=54445,MAXOUT=7,PACING=0,VPACING=0, C
          SSCPFM=USSSCS,MAXDATA=4105,MODETAB=LMT3270,MAXPATH=1, C
          ANS=CONT,ISTATUS=ACTIVE,DLOGMOD=B22NNE
PS06LU2 LU LOCADDR=02
PS06LU3 LU LOCADDR=03
PS06LU4 LU LOCADDR=04
PS06LU5 LU LOCADDR=05
```

### Configuring an LSA APPN Connection at the VTAM host

Configuring the VM or MVS host requires entries in two VTAM control blocks, the XCA Major Node Definition File and the Switched Major Node Definition File. See "VTAM Control Blocks Used to Configure LSA at the Host" on page 352 for a description of the purpose of these control blocks and references to VTAM publications.

### ***XCA Major Node Definition File - Sample:***

```
P15AP63X VBUILD TYPE=XCA
PORT63X PORT CUADDR=0CD,ADAPNO=0,TIMER=60,SAPADDR=04, C
MEDIUM=CSMACD
GRP63X GROUP DIAL=YES
*****
LN630403 LINE ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU630403 PU ISTATUS=ACTIVE
```

#### **Notes:**

1. ADAPNO is the LAN number for the 2216 LSA interface.
2. CUADDR is the channel address. This corresponds to the Device Address (two hexadecimal characters defining the lower byte of the channel address) for the 2216 interface.
3. MEDIUM=RING for Token Ring and MEDIUM=CSMACD for Ethernet. This corresponds to the value specified for LANtype for the 2216 LSA interface.

### ***Switched Major Node Definition File - Sample:***

```
LS601 VBUILD TYPE=SWNET
CS601 PU ADDR=02,CPNAME=C210,MAXOUT=7,PACING=0,VPACING=0, C
CPCP=YES,MAXDATA=4105,MODETAB=LMT3270,MAXPATH=10, C
CONNTYPE=APPN,DYNLU=YES
```

### **Configuring an LSA DLSw Connection at the VTAM Host**

Configuring the VM or MVS host requires entries in two VTAM control blocks, the XCA Major Node Definition File and the Switched Major Node Definition File. See "VTAM Control Blocks Used to Configure LSA at the Host" on page 352 for a description of the purpose of these control blocks and references to VTAM publications.

### ***XCA Major Node Definition File - Sample:***

```
P15AP60X VBUILD TYPE=XCA
PORT60X PORT CUADDR=0CC,ADAPNO=1,TIMER=60,SAPADDR=04, C
MEDIUM=CSMACD
GRP60X GROUP DIAL=YES
*****
LN600403 LINE ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU600403 PU ISTATUS=ACTIVE
LN600404 LINE ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU600404 PU ISTATUS=ACTIVE
```

#### **Notes:**

1. ADAPNO is the LAN number for the 2216 LSA interface.
2. CUADDR is the channel address. This corresponds to the Device Address (two hexadecimal characters defining the lower byte of the channel address) for the 2216 interface.
3. MEDIUM=RING for Token Ring and MEDIUM=CSMACD for Ethernet. This corresponds to the value specified for LANtype for the 2216 LSA interface.

### ***Switched Major Node Definition File - Sample:***

```
PSK5SW VBUILD TYPE=SWNET
PSK5PU PU ADDR=03,IDBLK=05D,IDNUM=07251,MAXOUT=7,PACING=0,VPACING=0, C
DLOGMOD=B22NNE, C
SSCPFM=USSSCS,MAXDATA=2000,MODETAB=LMT3270
PSK5LU2 LU LOCADDR=02
PSK5LU3 LU LOCADDR=03
PSK5LU4 LU LOCADDR=04
PSK5LU5 LU LOCADDR=05
PSK5LU6 LU LOCADDR=06
```

### **Configuring an LSA DLSw Local Conversion at the VTAM Host**

Configuring the VM or MVS host requires entries in two VTAM control blocks, the XCA Major Node Definition File and the Switched Major Node Definition File. See



“VTAM Control Blocks Used to Configure LSA at the Host” on page 352 for a description of the purpose of these control blocks and references to VTAM publications.

**XCA Major Node Definition File - Sample:**

```
P15AP60X VBUILD TYPE=XCA
PORT60X PORT CUADDR=0CC,ADAPNO=1,TIMER=60,SAPADDR=04, C
MEDIUM=CSMACD
GRP60X GROUP DIAL=YES
*****
LN600403 LINE ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU600403 PU ISTATUS=ACTIVE
LN600404 LINE ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU600404 PU ISTATUS=ACTIVE
```

**Notes:**

1. ADAPNO is the LAN number for the 2216 LSA interface.
2. CUADDR is the channel address. This corresponds to the Device Address (two hexadecimal characters defining the lower byte of the channel address) for the 2216 interface.
3. MEDIUM=RING for Token Ring and MEDIUM=CSMACD for Ethernet. This corresponds to the value specified for LANtype for the 2216 LSA interface.

**Switched Major Node Definition File - Sample:**

```
PS06SW VBUILD TYPE=SWNET,MAXDLUR=20
PS06PU PU ADDR=01,IDBLK=05D,IDNUM=54445,MAXOUT=7,PACING=0,VPACING=0, C
SSCPFM=USSSCS,MAXDATA=4105,MODETAB=LMT3270,MAXPATH=1, C
ANS=CONT,ISTATUS=ACTIVE,DLOGMOD=B22NNE
PS06LU2 LU LOCADDR=02
PS06LU3 LU LOCADDR=03
PS06LU4 LU LOCADDR=04
PS06LU5 LU LOCADDR=05
PSK5SW VBUILD TYPE=SWNET
PSK5PU PU ADDR=03,IDBLK=05D,IDNUM=07251,MAXOUT=7,PACING=0,VPACING=0, C
DLOGMOD=B22NNE, C
SSCPFM=USSSCS,MAXDATA=2000,MODETAB=LMT3270
PSK5LU2 LU LOCADDR=02
PSK5LU3 LU LOCADDR=03
PSK5LU4 LU LOCADDR=04
PSK5LU5 LU LOCADDR=05
PSK5LU6 LU LOCADDR=06
```

The following examples show XCA and SWNET macros that define the LAN major node for a Token-Ring adapter and an Ethernet adapter, respectively. In the examples:

- GROUP1T, GROUP1E, and GROUP1F represent resources connected to the LAN that require a VBUILD TYPE=SWNET.
- GROUP2T, GROUP2E, and GROUP2F represent a connection for the PU 5 node.

The mode table and default mode entries are examples only. Be sure to use the mode tables and mode entries defined in your installation.

```
TRLAN1 VBUILD TYPE=XCA
PORT1 PORT MEDIUM=RING,ADAPNO=0,CUADDR=644,TIMER=60,SAPADDR=4
GROUP1T GROUP DIAL=YES * Switched Attachment
LINE1TA LINE ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU1TA PU ISTATUS=ACTIVE
LINE1TB LINE ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU1TB PU ISTATUS=ACTIVE
GROUP2T GROUP DIAL=NO * Leased Definition
LINE2T LINE USER=SNA * Multi-domain Connection
PU2T PU MACADDR=400000000001,TGN=1,SUBAREA=2,SAPADDR=4,PUTYPE=5
```

```

ENLAN2  VBUILD TYPE=XCA
PORT2   PORT   MEDIUM=CSMACD,ADAPNO=0,CUADDR=645,TIMER=60,SAPADDR=4
GROUP1E GROUP  DIAL=YES      * Switched Attachment
LINE1EA LINE   ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU1EA   PU     ISTATUS=ACTIVE
LINE1EB LINE   ANSWER=ON,CALL=INOUT,ISTATUS=ACTIVE
PU1EB   PU     ISTATUS=ACTIVE
GROUP2E GROUP  DIAL=NO      * Leased Definition
LINE2E  LINE   USER=SNA     * Multi-domain Connection
PU2E    PU     MACADDR=40000000002,TGN=2,SUBAREA=2,SAPADDR=4,PUTYPE=5

```

The following examples are the switched major node definitions.

```

LS100SW VBUILD TYPE=SWNET,MAXGRP=400,MAXNO=400
CS100001 PU  ADDR=01,PUTYPE=2,MAXPATH=4,ANS=CONT,DLOGMOD=B22NNE,
          ISTATUS=ACTIVE,MAXDATA=521,I_RETRY=YES,MAXOUT=7,
          PASSLIM=5,IDBLK=111,IDNUM=00001,MODETAB=LMT3270
          PATH DIALNO=0104400000000004,GRPNM=GROUP1T
S00102  LU  LOCADDR=2
CS100002 PU  ADDR=02,PUTYPE=2,MAXPATH=4,ANS=CONT,DLOGMOD=B22NNE,
          ISTATUS=ACTIVE,MAXDATA=521,I_RETRY=YES,MAXOUT=7,
          PASSLIM=5,CPNAME=MYNS2,MODETAB=LMT3270
          PATH DIALNO=0104400000000005,GRPNM=GROUP1T
S00200  LU  LOCADDR=0,DLOGMOD=LU62MODE
S00202  LU  LOCADDR=2

CS100003 PU  ADDR=03,PUTYPE=2,MAXPATH=4,ANS=CONT,DLOGMOD=B22NNE,
          ISTATUS=ACTIVE,MAXDATA=521,I_RETRY=YES,MAXOUT=7,
          PASSLIM=5,IDBLK=111,IDNUM=00003,MODETAB=LMT3270
          PATH DIALNO=0104400000000006,GRPNM=GROUP1E
S00302  LU  LOCADDR=2
CS100004 PU  ADDR=04,PUTYPE=2,MAXPATH=4,ANS=CONT,DLOGMOD=B22NNE,
          ISTATUS=ACTIVE,MAXDATA=521,I_RETRY=YES,MAXOUT=7,
          PASSLIM=5,IDBLK=111,IDNUM=00004,MODETAB=LMT3270
          PATH DIALNO=0104400000000007,GRPNM=GROUP1E
S00402  LU  LOCADDR=2

CS100005 PU  ADDR=05,PUTYPE=2,MAXPATH=4,ANS=CONT,DLOGMOD=B22NNE,
          ISTATUS=ACTIVE,MAXDATA=521,I_RETRY=YES,MAXOUT=7,
          PASSLIM=5,IDBLK=111,IDNUM=00005,MODETAB=LMT3270
          PATH DIALNO=0104400000000008,GRPNM=GROUP1F
S00502  LU  LOCADDR=2
CS100006 PU  ADDR=06,PUTYPE=2,MAXPATH=4,ANS=CONT,DLOGMOD=B22NNE,
          ISTATUS=ACTIVE,MAXDATA=521,I_RETRY=YES,MAXOUT=7,
          PASSLIM=5,IDBLK=111,IDNUM=00006,MODETAB=LMT3270
          PATH DIALNO=0104400000000005,GRPNM=GROUP1F
S00602  LU  LOCADDR=2

```

For more information about VTAM definitions, see:

*IBM VTAM V4R4 Network Implementation Guide, SC31-8370*

*IBM VTAM V4R4 Resource Definition Reference, SC31-8377*

### Configuring the VTAM Host for MPC+ for APPN

Configuring the VTAM host for MPC+ for APPN requires entries in two VTAM control blocks, the Local SNA Major Node and the Transport Resource List (TRL) Major Node, and a change to the VTAM start-up parameters. A TRL corresponds to an MPC+ Group. For more information on configuring VTAM, refer to *IBM VTAM Resource Definition Reference*.

**Local SNA Major Node:** Use the following definition statements to configure a local SNA major node in VTAM:

```

UTYLSNA VBUILD TYPE=LOCAL
UTYHCC1 PU     TRLE=UHCC1,XID=YES,CONNTYPE=APPN,CPCP=YES,HPR=YES

```

### Transport Resource List (TRL) Major Node:

```

BC4UTRL VBUILD TYPE=TRL
UHCC1  TRLE LNCTL=MPC,
        MAXBFRU=n,
        READ=(xxx1,xxx2,...),
        WRITE=(yyy1,yyy2,...),
        REPLYTO=3.0
C
C
C
C

```

where:

**n** is the number of 4K buffer pages VTAM uses to receive data over the channel.

**xxx1,xxx2,...**  
are the read subchannel numbers. **1**

**yyy1,yyy2,...**  
are the write subchannel numbers. **1**

**1** The subchannels do not need to be contiguous.

The read and write subchannel numbers must be attached to those configured on the 2216 (for example, by way of a message operator mount or an attach command).

**Note:** A “read” subchannel to VTAM is a “write” subchannel to the 2216 and a “write” subchannel to VTAM is a “read” subchannel to the 2216.

**VTAM Start-up Parameters:** In the VTAM initialization file ATCSTRxx, where xx is defined by the user, define a network node:

```

NODETYPE=NN

```

Since high-performance routing (HPR) is being used, you also should add to this file:

```

HPR=YES

```

**Note:** Only APPN HPR is supported across the MPC+ interface. APPN ISR is not supported.

To activate the APPN PU, activate the associated TRLE (if it is not already active) and then activate the PU.

See *IBM VTAM Operation* for information about VTAM Commands.

## Configuring the VTAM Host for MPC+ for IP

**Note:** UDP+ is not supported on a Parallel Channel Adapter (PCA).

Configuring the VTAM host for MPC+ for TCP/IP or for HPDT UDP requires an entry in the VTAM Transport Resource List (TRL) Major Node control block. A TRL corresponds to an MPC+ Group. For more information on configuring VTAM, refer to *IBM VTAM Resource Definition Reference*.

### Transport Resource List (TRL) Major Node:

```

TRL  VBUILD TYPE=TRL
TRL1 TRLE LNCTL=MPC,
        MAXBFRU=n,
        READ=(xxx1,xxx2,...),
        WRITE=(yyy1,yyy2,...),
        REPLYTO=3.0
C
C
C
C

```

where:

**n** is the number of 4K buffer pages VTAM uses to receive data over the channel.

**Note:** For both TCP/IP and HPDT UDP, MAXBFRU\*4K must be greater than Maxdata coded on the MPC+ network handler in the 2216.

See *IBM OS/390 TCP/IP OpenEdition* and *IBM OS/390 Update Guide* for additional restrictions regarding MAXBFRU.

**xxx1,xxx2,...**

are the read subchannel numbers. **1**

**yyy1,yyy2,...**

are the write subchannel numbers. **1**

**1** The subchannels do not need to be contiguous.

The read and write subchannel numbers must match those configured on the 2216 (for example, by way of a message operator mount or an attach command).

**Note:** A “read” subchannel to VTAM is a “write” subchannel to the 2216 and a “write” subchannel to VTAM is a “read” subchannel to the 2216.

---

## Planning for 2216 Support

This section describes considerations for support of the 2216 and channel adapter in a network. Analyzing and resolving a communications problem between a channel adapter and a host or LAN may require you to initiate problem resolution procedures for the 2216.

The problem can be:

- A configuration or host definition problem
- A 2216 hardware or software problem
- A channel problem between the 2216 and the host
- A host program, resource, or hardware problem
- A LAN adapter, access unit, or other hardware malfunction
- A LAN workstation program or resource problem
- A communication problem between the 2216 and the LAN
- A problem using hardware or software

Indications of problems come from user reports, or indicators and displayed codes on the 2216 and other devices, or messages displayed by programs. These indications help you determine whether the problem is a hardware, software, or user problem. They also help you isolate the location (2216, LAN, host) and component (device, adapter, channel, or program) of the network that has the problem.

Determining the nature of the problem often indicates which procedures, tools, or additional information may be needed for resolution. The same tools, procedures, and information can also indicate the need to call for service. Problem resolution and service interfaces (NetView, SNMP Client) are available to the customer.

## 2216 Channel Adapter Problem Analysis and Resolution

The 2216 ESCON channel adapter and PCA problem isolation procedures described in *2216 Nways Multiaccess Connector Service and Maintenance Manual*, SY27-0350 should help you correct the problem, if possible, and determine when to call for service.

### Reconfiguration

Whenever your network grows, shrinks, or rearranges, you may need to reconfigure host programs and 2216 profiles to:

- Balance network traffic and workload
- Migrate to new versions or releases of host programs
- Migrate to new versions or releases of the 2216
- Change host SYSGENS

---

### Channel Adapter Overview

The ESCON Channel Adapter and PCA provides the 2216 with access to SNA and TCP/IP host applications from LANs, WANs, and ATM.

Figure 22 on page 360 shows a 2216 connected to a VTAM host through a channel adapter. Each ESCON channel adapter provides up to 64 subchannels and up to 32 associated virtual network handlers that can support LAN Channel Station (LCS), Link Services Architecture (LSA), and Multi-Path Channel (MPC+) protocols. Each Parallel Channel Adapter (PCA) provides up to 32 subchannels and up to 16 associated virtual network handlers. Each 2216 can contain up to four channel adapters.

Each ESCON Channel Adapter can provide connections to up to:

- 32 hosts or logical host images using LCS or MPC+ (when used with an ESCON Director)
- 64 hosts or logical host images using LSA (when used with an ESCON Director)
- 15 logical host images in EMIF-capable processors in logically partition mode when no ESCON director is present.

Each PCA can provide connection to one host or one logical host image.

## Planning for 2216 Support

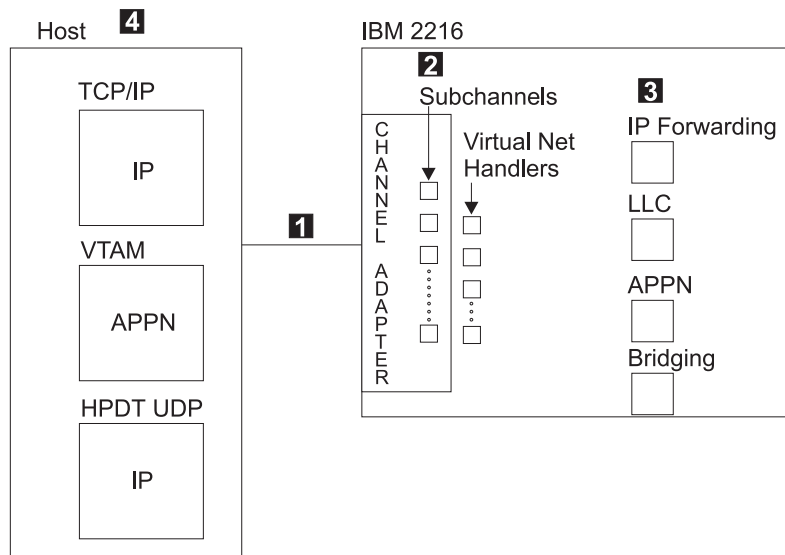


Figure 22. 2216 Connected to a Host through an ESCON/PCA Channel Adapter - Logical View

- 1 At the physical level, the ESCON Channel Adapter provides a flexible fiber optic connection to communication channels at the host processor. The physical level of the PCA is considerably more complex, requiring a pair of very large copper cables and a set of one to three (depending on configuration) smaller twisted pair copper cables to provide final connection to the PCA.
- 2 At the logical level, the channel adapter provides up to 64 *subchannels* and up to 32 associated *virtual network handlers*.

Each virtual network handler supports one of the following protocols:

- LCS** LAN Channel Station
- LSA** Link Services Architecture
- MPC+** Multi-Path Channel+

For each LCS virtual network handler, you must define two subchannels, one for read and one for write; you can define up to 32 LCS virtual network handlers for each ESCON channel adapter and up to 16 for each PCA.

For each LSA virtual network handler, you must define at least one subchannel up to a maximum of 64 subchannels. You can define up to 32 LSA virtual network handlers for each ESCON channel adapter and up to 16 for each PCA.

For MPC+, you can define up to 64 subchannels. You must have at least one read subchannel and at least one write subchannel. You can define up to 32 MPC+ virtual network handlers for each ESCON channel adapter and up to 16 for each PCA.

### Notes:

1. You can configure LCS and LSA on the same channel adapter.
2. For migration purposes, MPC+ may be configured on the same channel adapter as LCS/LSA. This is not recommended as a long term solution.

MPC+ combined with another type of virtual interface (LCS/LSA) on the same adapter could impact the performance benefits provided by the MPC+ interface.

- 3 The 2216 channel adapter provides services for IP Forwarding, Logical Link Control (LLC), Advanced Peer-to-Peer Networking (APPN), and bridging.
- 4 The virtual net handlers provide connections for transmitting and receiving packets of information for host applications as shown in Figure 23 and Figure 24 on page 362.

Once the channel adapter is installed and configured for LCS, LSA, and MPC+, it can provide:

- Hierarchical SNA, including DLSw traffic, and APPN ISR and HPR traffic running over LSA connections. (DLSw and APPN require LLC loopback.)
- TCP/IP traffic running over LCS and MPC+.
- APPN HPR traffic running over MPC+.
- HPDT UDP traffic running over MPC+.

**Note:** UDP+ is not supported on a Parallel Channel Adapter (PCA).

Figure 23 shows the basic flow for a channel adapter with LCS and LSA configured, and Figure 24 on page 362 shows the basic flow for a channel adapter for which MPC+ is configured.

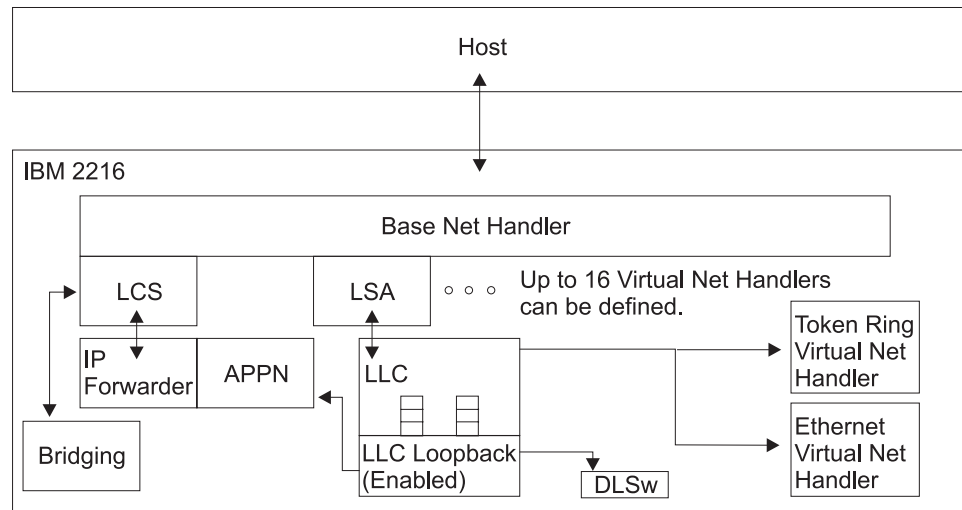


Figure 23. 2216 Virtual Net Handlers for LCS and LSA

## Planning for 2216 Support

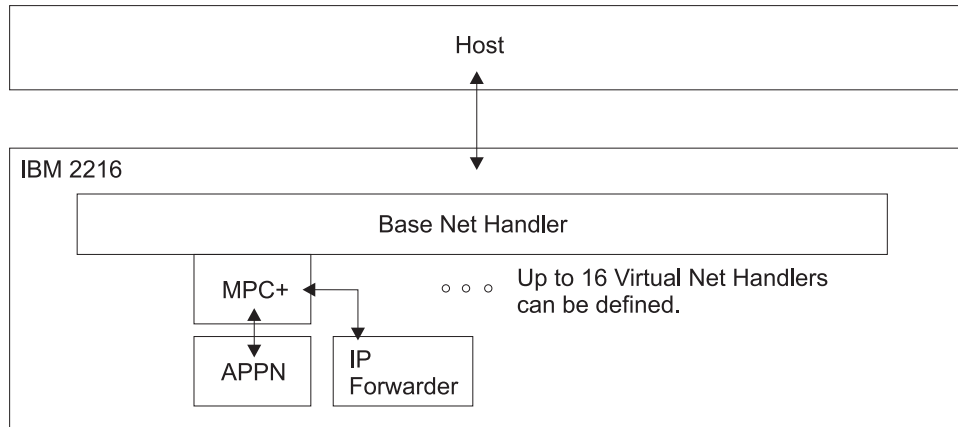


Figure 24. 2216 Virtual Net Handlers for MPC+

## LAN Channel Station (LCS) Support

Figure 25 shows how TCP/IP data flows from the host, through LCS and other 2216 software components, and out to the LANs/WANs.

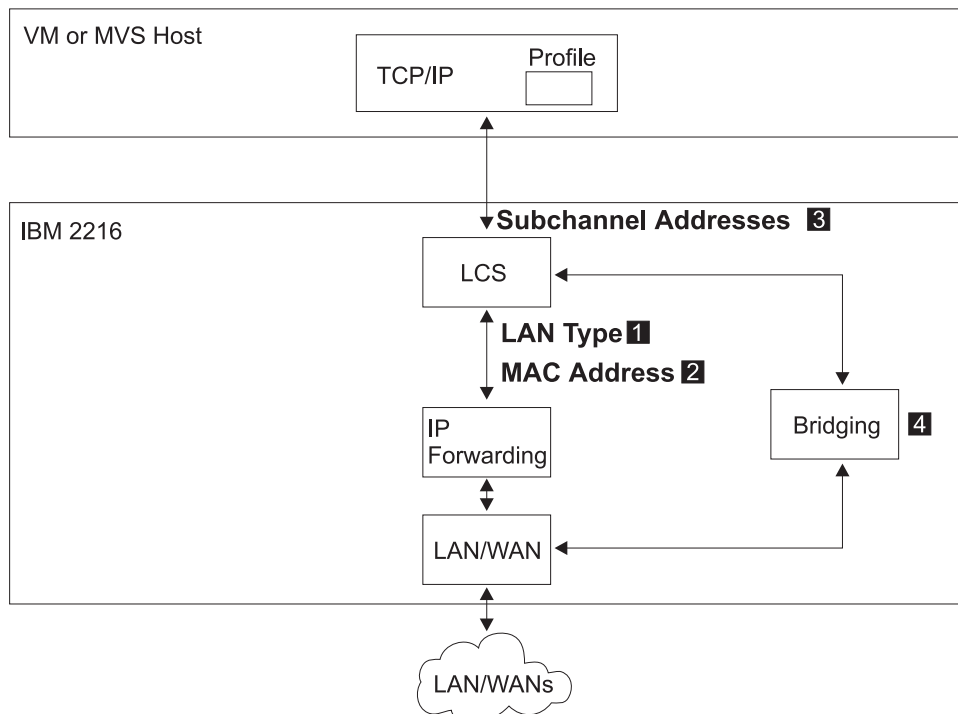


Figure 25. Configuring LAN Channel Station (LCS) Virtual Net Handlers. This figure shows LCS flow and highlights key parameters at the host and in the 2216.

### Configuring the 2216 for LCS

Figure 25 shows an LCS connection. To configure the 2216 for LCS:

1. Configure the LAN type ( **1** ), either Ethernet, Token Ring, or FDDI, for the connection. This is the frame type that the host expects to send and receive.
2. Configure a unique MAC address ( **2** ) for this virtual interface.

**Note:** If the LAN type is Ethernet, then the MAC address must be in canonical format.



3. Configure the subchannel pair ( **3** ) used by this connection as described in “Configuring an LCS Subchannel” on page 382.
4. ( **4** ) If you want to route IP, configure an IP address and mask on the LCS virtual network handler. Refer to Configuring IP chapter in the *Protocol Configuration and Monitoring Reference Volume 1* for information on configuring IP routing. If you want to bridge IP, configure bridging on the LCS virtual network handler. Bridging IP on the LCS virtual network handler is called *TCP/IP Passthru*. See “TCP/IP Passthru” for more information on configuring bridging.

You must configure an IP address and mask. Refer to *Protocol Configuration and Monitoring Reference Volume 1*.

There are optional parameters:

**maxdata**

Maximum size of data handled by this virtual network.

**acklen**

The size (in bytes) of acknowledgment frames over this interface.

**blktimer**

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

For information on the corresponding host definitions, see “Configuring the Host for TCP/IP” on page 345.

**TCP/IP Passthru**

TCP/IP Passthru bridges, rather than routes, IP frames received on an LCS virtual network handler to a LAN or WAN interface. To use this feature, you must configure bridging on the LCS virtual network handlers and the LAN and WAN interfaces that you wish to interconnect. See Configuring and Monitoring Bridging in *Protocol Configuration and Monitoring Reference Volume 1* for more information on configuring bridging. The type of bridging you will configure depends on the LAN type of the LCS virtual network interfaces. The following table shows the appropriate bridging parameters for each LCS LAN type.

LCS LAN Type	Bridging Type	Forward STE Frames
Token-Ring	Source Routing, Transparent, or both	Enabled
Ethernet	Transparent	N/A
FDDI	Transparent	N/A

**Note:** The Spanning Tree protocol is automatically disabled on the LCS virtual network handler.

**Attention:** You cannot configure both an IP address and bridging for an LCS. If you specify both, the configuration program operates as if you had specified only the IP address option. If you want to bridge IP frames, do not specify an IP address.

**3172 Emulation Using LCS Passthru**

LCS Passthru allows the IBM 2216 to function as a 3172 replacement in TCP/IP networks. Frames received from a TCP/IP host are passed directly to a downstream LAN adapter, bypassing the IP router and bridging functions of the IBM 2216. IP and ARP frames received by a LAN adapter associated with the LCS passthru

## Planning for 2216 Support

function are passed directly to the LCS net handler for delivery to the TCP/IP host. The IBM 2216 replaces the 3172 LCS function without requiring changes in IP network topology or adding additional bridge hops.

The following example describes LCS Passthru configuration:

```
*t 6
Gateway user configuration
Config>add dev esc
Device Slot #(1-8) [1]?3
Adding ESCON Channel device in slot 3 port 1 as interface #4
Use "net 4" to configure ESCON Channel parameters
Config>net 4
ESCON Config>add lcs
ESCON Add Virtual>?
LANtype
MAC address
MAXdata
BLKtimer
ACKlen
SUBchannels
ENable 3172 Emulation
Exit
ESCON Add Virtual>enable
Enabling LCS 3172 Emulation for network 5.
Please set the Network link using the "NET" command.
ESCON Add Virtual>?
BLKtimer
ACKlen
SUBchannels
DISable 3172 Emulation
NET link
Exit
ESCON Add Virtual>net 0
ESCON Add Virtual>sub add
Please add or configure one subchannel for an LCS virtual interface.
Although LCS requires two subchannels, it is only necessary to specify
one subchannel. An adjacent subchannel will be chosen such that the two
subchannels will form a sequential pair with the write subchannel (device
address is even) before the read subchannel (device address is odd).
ESCON Config LCS Subchannel>?
LINK address (ESCD Port)
LPAR number
CU logical address
Device address
Exit
ESCON Config LCS Subchannel>link f7
ESCON Config LCS Subchannel>lpar 0
ESCON Config LCS Subchannel>cu 0
ESCON Config LCS Subchannel>dev 20
ESCON Config LCS Subchannel>ex
ESCON Add Virtual>ex
ESCON Config>list
Net: 5 Protocol: LCS LAN type: Token Ring LAN number: 0
      3172 Emulation is enabled.
      MAC address: Obtained from net 0
      Block Timer: 5 ms ACK length: 10 bytes
ESCON Config>list all
Net: 5 Protocol: LCS LAN type: Token Ring LAN number: 0
      3172 Emulation is enabled.
      MAC address: Obtained from net 0
      Block Timer: 5 ms ACK length: 10 bytes
      Read Subchannels:
      Sub 0 Dev addr: 21 LPAR: 0 Link addr: F7 CU addr: 0
      Write Subchannels:
      Sub 1 Dev addr: 20 LPAR: 0 Link addr: F7 CU addr: 0

ESCON Config>
```

## Link Services Architecture (LSA) Support

Link Services Architecture (LSA) permits the VTAM host to communicate with the channel adapter in the 2216.

Figure 26 on page 365 shows the four types of LSA connections. Their configuration is described in:

## Planning for 2216 Support

- “Configuring an LSA Direct Connection at the 2216” on page 366
- “Configuring an LSA APPN Connection at the 2216” on page 367
- “Configuring an LSA DLSw Connection at the 2216” on page 368
- “Configuring an LSA DLSw Local Conversion at the 2216” on page 370

For information on the corresponding host definitions, see “VTAM Control Blocks Used to Configure LSA at the Host” on page 352.

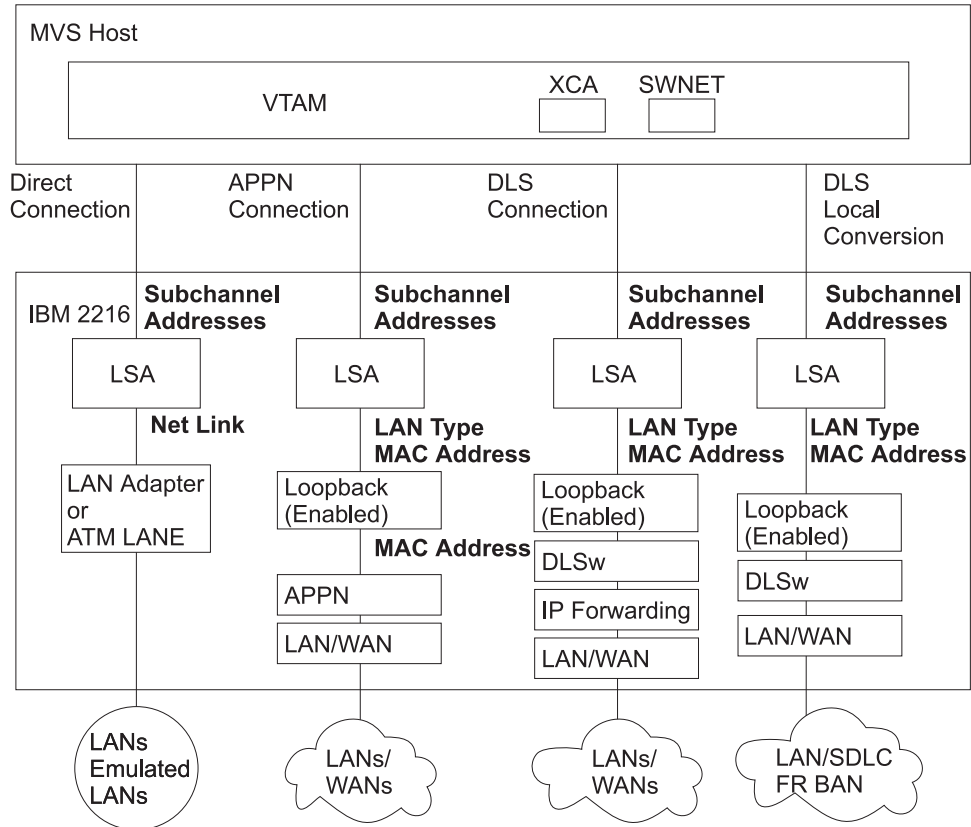


Figure 26. Configuring Link Services Architecture (LSA) Virtual Net Handlers

## Configuring an LSA Direct Connection at the 2216

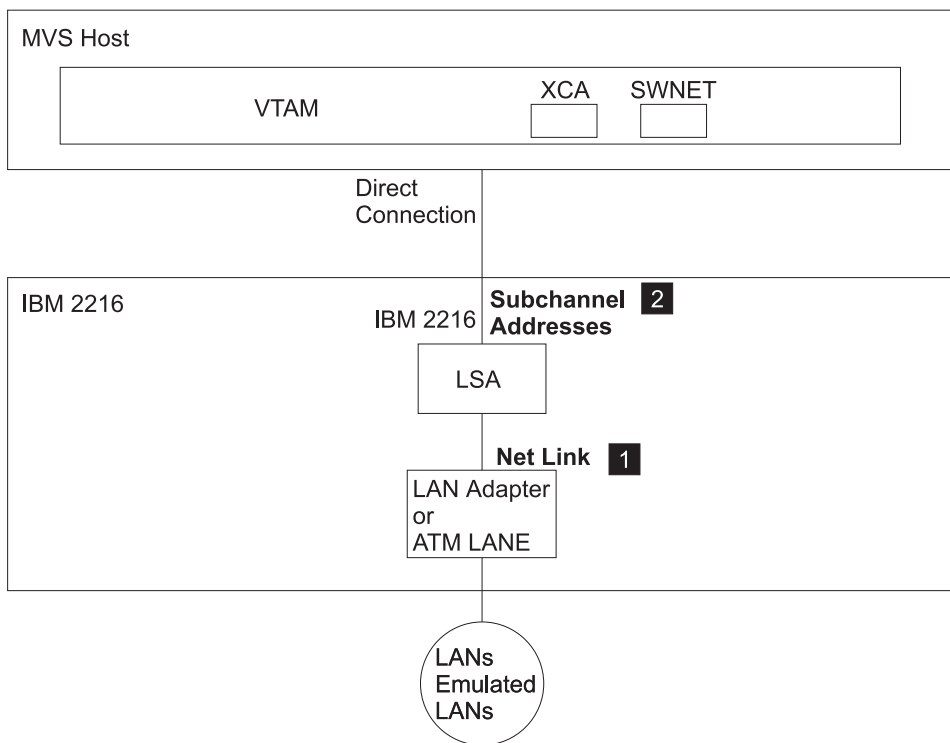


Figure 27. Configuring Virtual Net Handlers for LSA Direct Connection

Figure 27 shows an LSA direct connection. To configure the LSA connection:

1. Configure the net link ( **1** ). This is the network interface number of the LAN adapter to which the LSA network is linked. This is the interface used by the 2216 to transmit data from the host to the network.
2. Configure the subchannel or subchannels ( **2** ) used by this connection as described in “Configuring an LSA Subchannel” on page 386.

There are optional parameters:

**maxdata**

Maximum size of data handled by this virtual network.

**acklen**

The size (in bytes) of acknowledgment frames over this interface.

**blktimer**

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

**Note:** The LSA net will read its MAC address from the 2216 interface configured with the Net Link command.

For information on the corresponding host definitions, see “Configuring an LSA Direct Connection at the VTAM Host” on page 353.

## Configuring an LSA APPN Connection at the 2216

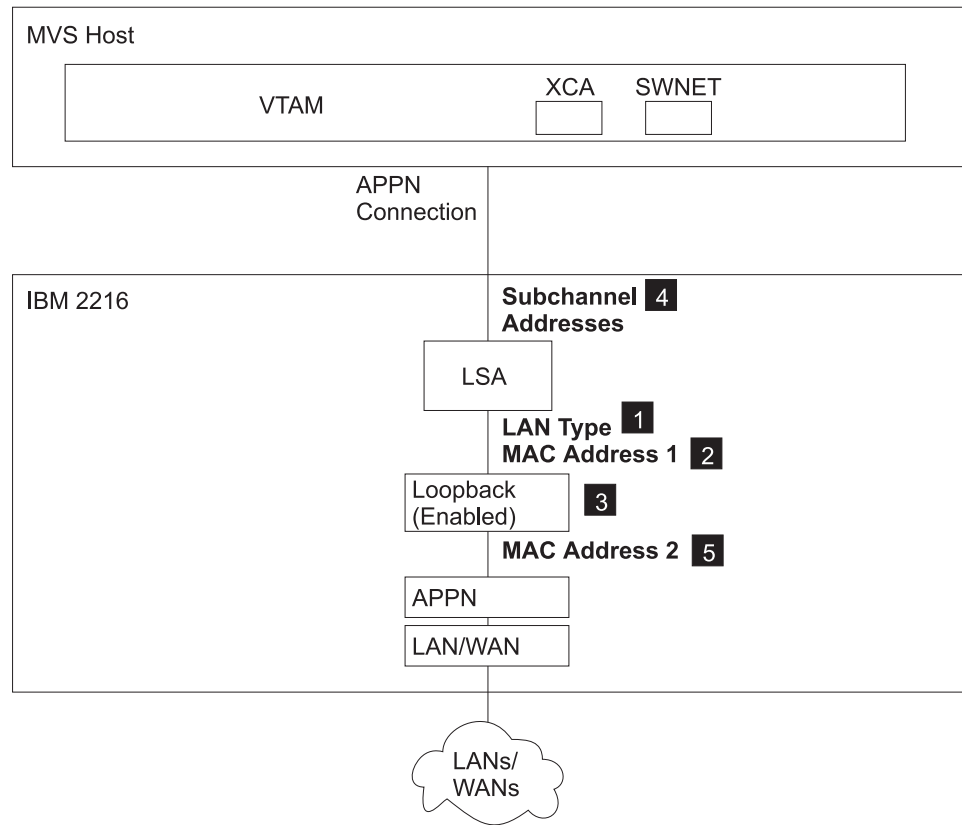


Figure 28. Configuring Virtual Net Handlers for LSA APPN Connection

Figure 28 shows an LSA APPN connection. To configure the 2216 for an LSA APPN connection:

1. Enable LSA loopback ( **3** ) using the **enable** command.
2. Configure the LAN type ( **1** ), either Ethernet or Token Ring

**Note:** You must configure the same LAN type for both the LSA net and the Loopback net.

3. Configure a unique MAC address ( **2** ) to identify the host (VTAM) end of the loopback connection.

**Note:** If the LAN type is Ethernet, then the MAC address must be in canonical format.

4. Configure the subchannel or subchannels ( **4** ) used by this connection as described in “Configuring an LSA Subchannel” on page 386.

There are optional parameters:

**maxdata**

Maximum size of data handled by this virtual network.

**acklen**

The size (in bytes) of acknowledgment frames over this interface.

**blktimer**

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

## Planning for 2216 Support

- Configure APPN to use the APPN loopback net. The APPN port must be configured on the APPN loopback net. To then configure an APPN link station over this APPN port, the destination MAC address of the link station definition should be that of the LSA net.
- Configure MAC Address 2 ( **5** ), a unique MAC address to identify the 2216 (APPN) end of the loopback connection.

**Note:** If the LAN type is Ethernet, then the MAC address must be in canonical format.

For information on the corresponding host definitions, see “Configuring an LSA APPN Connection at the VTAM host” on page 353.

## Configuring an LSA DLSw Connection at the 2216

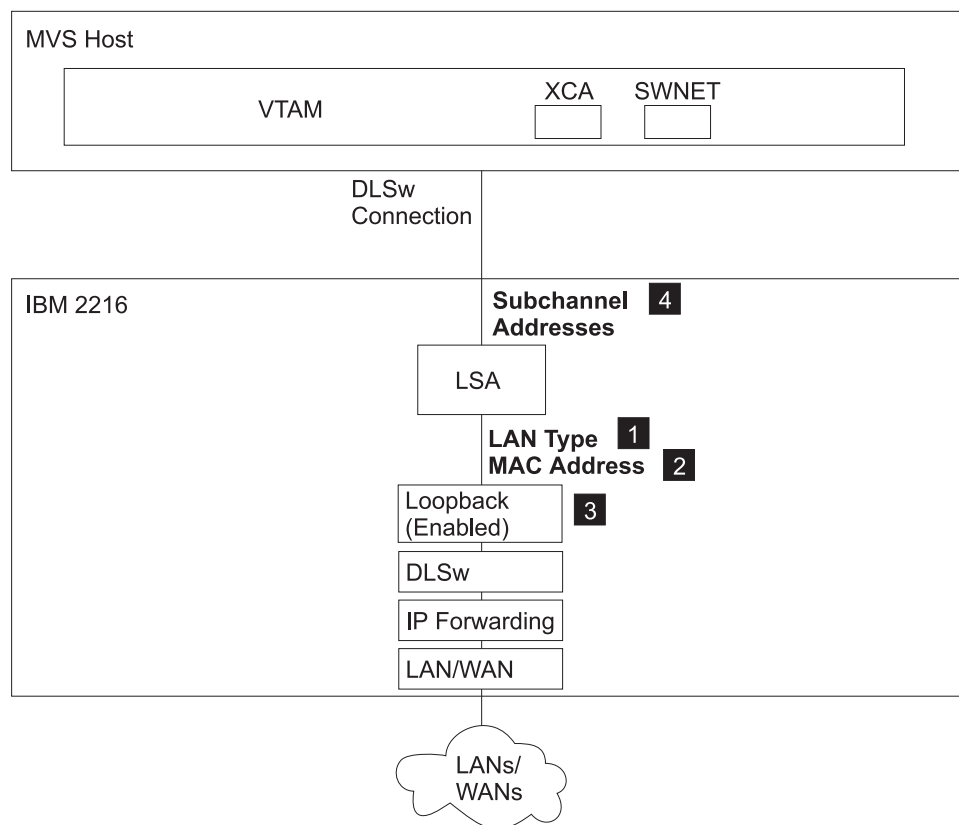


Figure 29. Configuring Virtual Net Handlers for LSA DLSw Connection

Figure 29 shows an LSA DLSw connection. To configure an LSA DLSw connection:

- Enable LSA loopback ( **3** ) using the **enable** command.
- Configure the LAN type ( **1** ), either Ethernet or Token Ring. This is the frame type that the host expects to send and receive.
- Configure a unique MAC address ( **2** ) to identify the host (VTAM) end of the loopback connection.

**Note:** If the LAN type is Ethernet, then the MAC address must be in canonical format.

- Configure the subchannel or subchannels ( **4** ) used by this connection as described in “Configuring an LSA Subchannel” on page 386.

5. Configure DLSw. Configuring DLSw involves enabling DLSw, setting the DLSw segment number, adding the remote DLSw TCP partner and opening the service access points (SAPs) associated with the loopback interface that will be used for DLSw. Configure DLSw from the `config>` prompt.

Enable DLSw, using the `enable dls` command.

Set the DLSw segment number using the `set srb` command. The DLSw segment number must be unique.

Add the remote DLSw TCP partner using the `add tcp` command.

Open the SAPs that will be used with the LSA loopback interface using the `open` command. The `open` command will prompt for an interface number. Input the interface number assigned to the LSA loopback interface that is defined for use with DLSw.

For a description of the DLSw configuration parameters, refer to the chapter entitled "Using and Configuring DLSw" in the *Protocol Configuration and Monitoring Reference Volume 1*.

There are optional parameters:

**maxdata**

Maximum size of data handled by this virtual network.

**acklen**

The size (in bytes) of acknowledgment frames over this interface.

**blktimer**

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

For information on the corresponding host definitions, see "Configuring an LSA DLSw Connection at the VTAM Host" on page 354.

## Configuring an LSA DLSw Local Conversion at the 2216

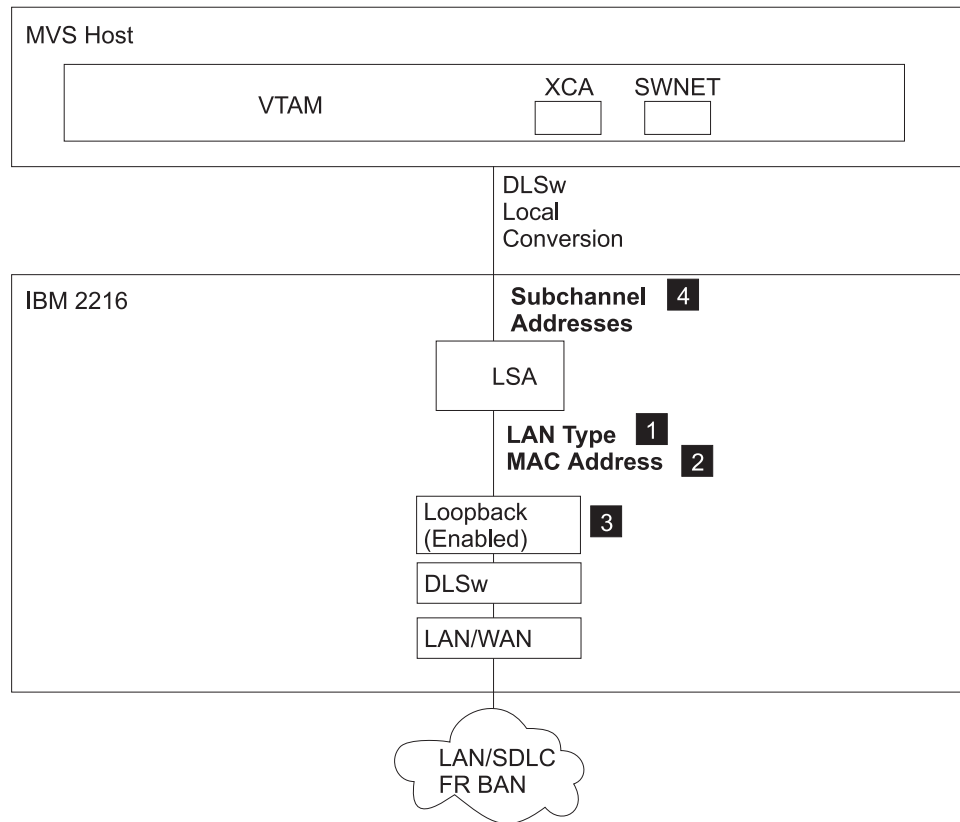


Figure 30. Configuring Virtual Net Handlers for LSA DLSw Local Conversion

Figure 30 shows a configuration that supports LSA DLSw local conversion. To configure a 2216 for LSA DLSw conversion:

1. Enable LSA loopback ( **3** ) using the **enable** command.
2. Configure the LAN type ( **1** ), either Ethernet or Token Ring. This is the frame type that the host expects to send and receive.
3. Configure a unique MAC address ( **2** ) to identify the host (VTAM) end of the loopback connection.

**Note:** If the LAN type is Ethernet, then the MAC address must be in canonical format.

4. Configure the subchannel or subchannels ( **4** ) used by this connection as described in “Configuring an LSA Subchannel” on page 386.
5. Configure DLSw. Configuring DLSw involves enabling DLSw, setting the DLSw segment number, adding the local DLSw TCP partner and opening the service access points (SAPs) associated with the loopback interface that will be used for DLSw. Configure DLSw from the `config>` prompt.

Enable DLSw, using the `enable dls` command.

Set the DLSw segment number using the `set srb` command. The DLSw segment number must be unique. The DLSw segment number must be different from segment numbers assigned to other interfaces.

Add the local DLSw TCP partner using the `add tcp` command.



Open the SAPs that will be used with the LSA loopback interface using the open command. The open command will prompt for an interface number. Input the interface number assigned to the LSA loopback interface that is defined for use with DLSW.

Opening SAPs and configuring bridging on the local LAN/WAN interfaces might be required. Opening the SAPs and configuring bridging permits incoming frames to be forwarded to DLSw.

**Note:** Each LSA interface can support up to 10240 LLC link stations per SAP. An LSA interface can support multiple SAPs.

For a description of the DLSw configuration parameters, refer to the chapter entitled "Using and Configuring DLSw" in the *Protocol Configuration and Monitoring Reference Volume 1*.

There are optional parameters:

**maxdata**

Maximum size of data handled by this virtual network.

**acklen**

The size (in bytes) of acknowledgment frames over this interface.

**blktimer**

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

## Multi-Path Channel+ (MPC+) Support

Multi-Path Channel+ (MPC+) permits the VTAM host to communicate with the channel adapter in the 2216. An MPC+ Group is a set of subchannels, containing at least one read and one write subchannel, whose end points converge at a common MPC+ image in the VTAM Host.

## Planning for 2216 Support

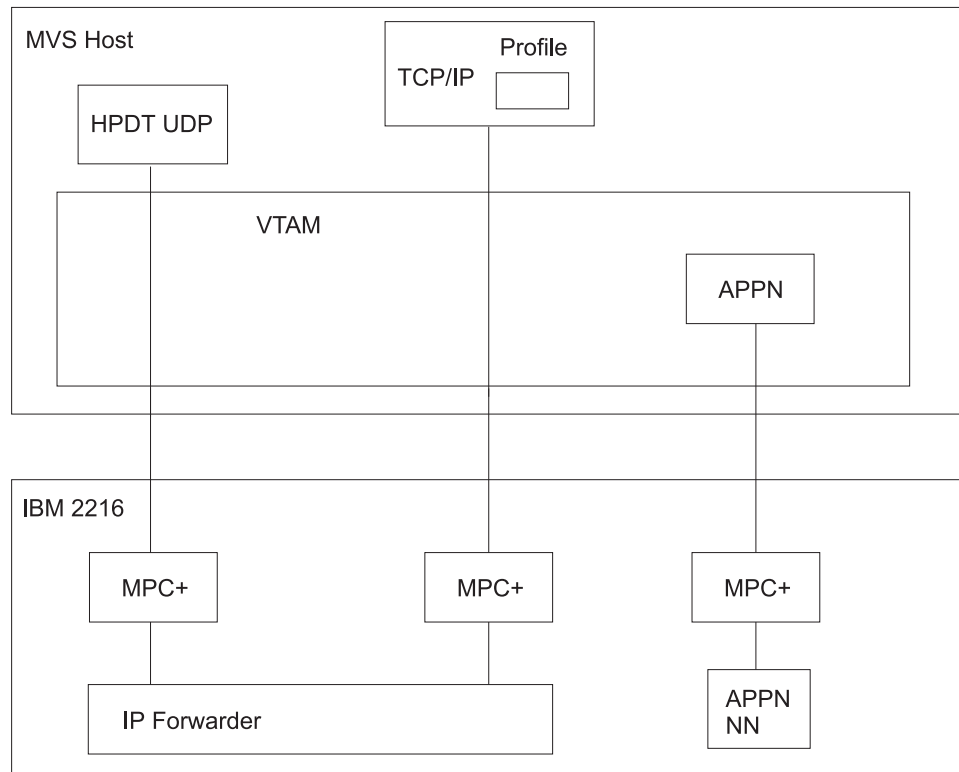


Figure 31. Different types of MPC+ Connections.

**Note:** UDP+ is not supported on a Parallel Channel Adapter (PCA).

Figure 31 shows the three types of MPC+ connections. The following sections describe the types in more detail:

- “Configuring the 2216 for APPN over MPC+”
- “Configuring the 2216 for UDP+ Over MPC+ (ESCON Channel Adapter Only)” on page 374
- “Configuring the 2216 for TCP/IP Over MPC+” on page 375

For information on the corresponding host definitions, see “Defining the 2216 to Host Programs” on page 345.

To configure an MPC+ Group in the 2216, configure an MPC+ interface on a base ESCON or PCA interface.

- An MPC+ connection to HPDT UDP in the host requires a dedicated MPC+ Group. An MPC+ Group that is dedicated cannot be shared by any other users or protocols.

**Note:** UDP+ is not supported on a Parallel Channel Adapter (PCA).

- An MPC+ Group that is not dedicated can be shared by multiple TCP/IPs and by APPN.
- There can be multiple MPC+ Groups on a single channel adapter.

### Configuring the 2216 for APPN over MPC+

Figure 32 on page 373 shows MPC+ flow and highlights key parameters at the host and in the 2216.

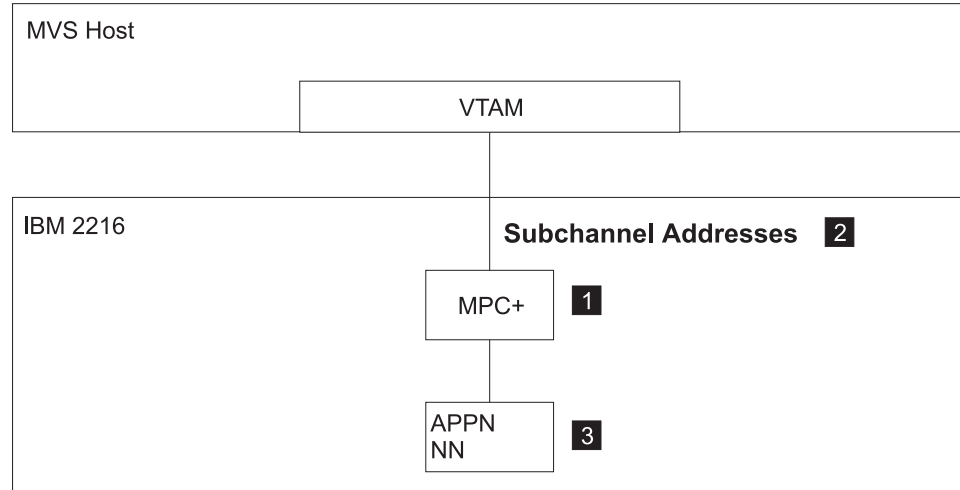


Figure 32. Configuring Virtual Net Handlers for APPN over Multi-Path Channel+ (MPC+)

Figure 32 shows the parameters required to configure MPC+ for APPN.

**1** Configure the MPC+ Virtual Interface as described in “Configuring an MPC+ Virtual Interface” on page 388.

**2** Configure subchannels for read and write connections to the host as described in “Configuring an MPC+ Subchannel” on page 389.

**Note:** Do not enable UDP+ exclusive use on the MPC+ interface. Ignore the disable outbound protocol data blocking parameter. It does not apply and has no effect for APPN.

There are optional parameters:

**reply timeout**

Timer for XID2/Disconnect timeout in milliseconds.

This is the amount of time that the MPC+ Group waits to hear from across the channel during XID2 and DISC exchanges before deciding that the other end of the channel is not answering and that this side should continue with the bring up or bring down of the MPC+ Group.

**sequencing interval timer**

Sequencing Interval Timer in milliseconds.

This timer is used to determine whether connection-oriented data is flowing smoothly across the connection on an MPC+ Group. The MPC+ control flows flow connection-oriented. Since these commands must have guaranteed delivery at the link level they flow connection-oriented and the Sequencing Interval timer is used to determine whether enough time has passed that checking of the delivery of connection-oriented traffic should be done.

**maxdata**

Maximum size of data handled by this virtual network handler.

**acklen**

The size (in bytes) of acknowledgment frames over this interface.

## Planning for 2216 Support

### blktimer

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

**3** With the following exceptions, APPN is configured over the MPC+ interface as it is over other interface types:

- On the APPN “add port” command, specify link type MPC+.
- On the APPN “add port” command, you may specify the MPC+ sequencing interval timer.

For information on the corresponding host definitions, see “Configuring the VTAM Host for MPC+ for APPN” on page 356.

### Configuring the 2216 for UDP+ Over MPC+ (ESCON Channel Adapter Only)

Figure 33 graphically illustrates a UDP+ configuration over MPC+.

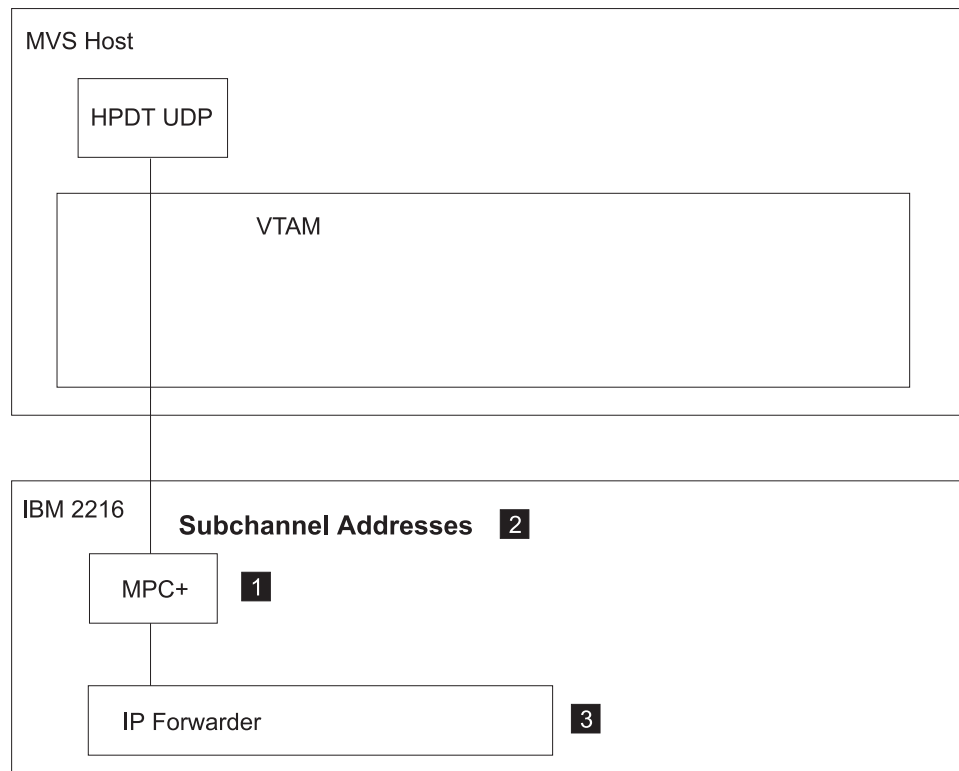


Figure 33. Configuring Virtual Net Handlers for UDP+ over MPC+

**1** Configure the MPC+ Virtual Interface as described in “Configuring an MPC+ Virtual Interface” on page 388.

Enable UDP+ exclusive use on the MPC+ interface.

There are optional parameters:

#### reply timeout

Timer for XID2/Disconnect timeout in milliseconds.

This is the amount of time that the MPC+ Group waits to hear from across the channel during XID2 and DISC exchanges before deciding that the

other end of the channel is not answering and that this side should continue with the bring up or bring down of the MPC+ Group.

### sequencing interval timer

Sequencing Interval Timer in milliseconds.

This timer is used to determine whether connection-oriented data is flowing smoothly across the connection on an MPC+ Group. The MPC+ control flows are connection-oriented. Since these commands must have guaranteed delivery at the link level they flow connection-oriented and the Sequencing Interval timer is used to determine whether enough time has passed that checking of the delivery of connection-oriented traffic should be done.

### maxdata

Maximum size of data handled by this virtual network handler.

**Note:** This value must equal the MTU coded for HPDT UDP in the host.

### acklen

The size (in bytes) of acknowledgment frames over this interface.

### blktimer

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

### outbound protocol blocking

Generally this parameter should be left enabled. See “Configuring an MPC+ Virtual Interface” on page 388 for details.

**2** Configure subchannels for read and write connections to the host as described in “Configuring an MPC+ Subchannel” on page 389.

**3** IP is configured over the MPC+ interface in the same manner that it is configured over other interface types; however:

- Only one IP address should be configured for a UDP+ MPC+ interface. This address must be equal to the destination\_IP\_address coded for HPDT UDP in the host.

**Note:** If more than one IP address is configured, the last one configured is the one that is used.

- The source\_IP\_address coded for HPDT UDP in the host must be in the same IP subnetwork as the IP address configured in the 2216 on the UDP+ MPC+ interface.

For information on the corresponding host definitions, see “Configuring the Host for HPDT UDP:” on page 351.

## Configuring the 2216 for TCP/IP Over MPC+

Figure 34 on page 376 graphically illustrates a TCP/IP configuration over MPC+.

## Planning for 2216 Support

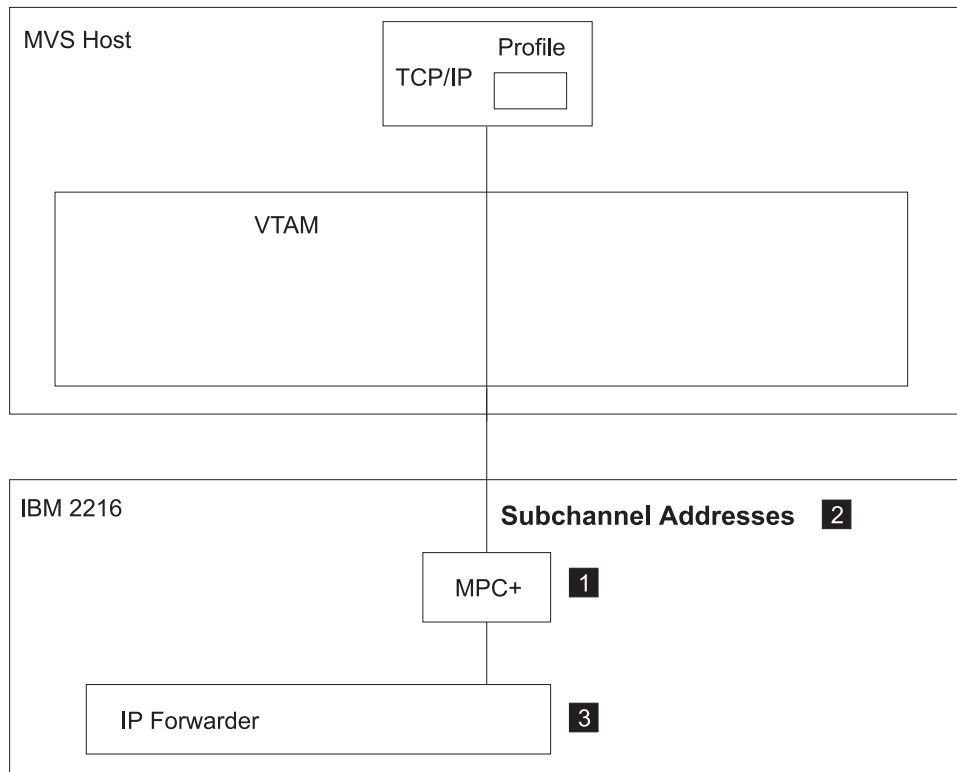


Figure 34. Configuring Virtual Net Handlers for TCP/IP over MPC+

**1** Configure the MPC+ Virtual Interface as described in “Configuring an MPC+ Virtual Interface” on page 388.

**Note:** Do not enable UDP+ exclusive use on the MPC+ interface. TCP/IP is configured on an MPC+ interface by virtue of configuring IP addresses for the MPC+ network handler and having the MPC+ interface not be configured for the exclusive use of UDP+.

There are optional parameters:

### reply timeout

Timer for XID2/Disconnect timeout in milliseconds.

This is the amount of time that the MPC+ Group waits to hear from across the channel during XID2 and DISC exchanges before deciding that the other end of the channel is not answering and that this side should continue with the bring up or bring down of the MPC+ Group.

### sequencing interval timer

Sequencing Interval Timer in milliseconds.

This timer is used to determine whether connection-oriented data is flowing smoothly across the connection on an MPC+ Group. The MPC+ control flows flow connection-oriented. Since these commands must have guaranteed delivery at the link level they flow connection-oriented and the Sequencing Interval timer is used to determine whether enough time has passed that checking of the delivery of connection-oriented traffic should be done.

### maxdata

Maximum size of data handled by this virtual network handler.

**Notes:**

1. This value must be less than or equal to the maximum amount of data the host can handle receiving over the channel (that is, MAXBFRU\*4K, where MAXBFRU is from the VTAM TRLE corresponding to this MPC+ interface in the 2216).
2. The 2216 will never send an IP packet longer than maxdata across the MPC+ Group. However, depending upon the values for maxdata configured for other virtual network handlers using the same base channel interface as this MPC+ interface, the 2216 may actually accept a larger IP packet from the host.

**acklen**

The size (in bytes) of acknowledgment frames over this interface.

**blktimer**

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

**outbound protocol blocking**

Generally this parameter should be left enabled. See “Configuring an MPC+ Virtual Interface” on page 388 for details.

**2** Configure subchannels for read and write connections to the host as described in “Configuring an MPC+ Subchannel” on page 389.

**3** IP is configured over the MPC+ interface in the same manner that it is configured over other interface types; however:

- Multiple TCP/IP over MPC+ interface connections can be established over a single MPC+ interface.
- In order to establish a TCP/IP over MPC+ connection, the TCP/IP HOME IP address must be in the same IP subnetwork as one of the IP addresses configured in the 2216 on the MPC+ interface.
- If multiple TCP/IP instances in the host are in the same IP subnetwork as configured for the 2216 MPC+ interface, multiple TCP/IP over MPC+ connections will be set up using the same 2216 IP address.

For information on the corresponding host definitions, see “Configuring the Host for TCP/IP” on page 345.

## Configuring the Channel Adapter Interface

The following steps are required to configure the ESCON or PCA interface:

1. Access the ESCON or PCA interface as described in “Accessing the Channel Interface” on page 379. This will cause the base interface to be defined.
2. Configure the virtual net handlers as described in:
  - “Configuring an LCS Virtual Interface” on page 381
  - “Configuring an LSA Virtual Interface” on page 384
  - “Configuring an MPC+ Virtual Interface” on page 388
3. Configure the subchannels:
  - “Configuring an LCS Subchannel” on page 382
  - “Configuring an LSA Subchannel” on page 386
  - “Configuring an MPC+ Subchannel” on page 389

Once the 2216 ESCON or PCA configuration is complete,

- Configure the protocols.
- Save the configuration.

## Planning for 2216 Support

- Reboot the 2216 to activate changes.



---

## Chapter 29. Configuring and Monitoring the ESCON and Parallel Channel Adapters

This chapter describes the Enterprise Systems Connection (ESCON) and Parallel Channel Adapter configuration and operational commands. It contains the following sections:

- “Accessing the Channel Interface”
- “Channel Adapter Configuration Commands” on page 380
- “Accessing the Channel Interface Monitoring Process” on page 399
- “Channel Interface Monitoring Commands” on page 399
- “Channel Adapter LCS Interface Monitoring Commands” on page 403
- “Channel Adapter LSA Interface Monitoring Commands” on page 406
- “Channel Adapter MPC+ Interface Monitoring Commands” on page 408
- “Chapter 30. ESCON Channel Dynamic Reconfiguration Support” on page 415
- “Chapter 31. PCA Channel Dynamic Reconfiguration Support” on page 417
- “Chapter 32. LSA Virtual Channel Dynamic Reconfiguration Support” on page 419
- “Chapter 33. LCS Virtual Channel Dynamic Reconfiguration Support” on page 421
- “Chapter 34. MPC Virtual Channel Dynamic Reconfiguration Support” on page 423
- “Chapter 35. APPN Loopback Interface Dynamic Reconfiguration Support” on page 425

For additional monitoring information, refer to *Software User's Guide*.

### Note About Examples

Throughout this following sections there are examples of ESCON and PCA interface configurations. In areas where there is a significant difference between ESCON and PCA, there will be multiple examples.

---

## Accessing the Channel Interface

To access the channel adapter interface:

1. At the OPCON prompt, enter **talk 6**. For example:

```
* talk 6
  Config>
```

After you enter the **talk 6** command, the CONFIG prompt (Config>) displays on the console. If the prompt does not appear, press **Return** again.

2. Enter the **list devices** command to display the network interface numbers that are currently configured.
3. Record the interface numbers.
4. Create a channel interface by either:
  - Entering the **add device esc** command at the Config> prompt to create an ESCON channel.

```
Config> add dev esc
Device Slot x(1-8) 1?
Adding ESCON Adapter device in slot 1 port 1 as interface x
```

**Note:** x is the assigned interface number.

**Note:** The 2216 has eight slots, numbered 1 to 8.

- Entering the **add device pca** command at the Config> prompt.

```
Config> add dev pca
Device Slot x(1-8) 1?
Adding PCA device in slot 1 port 1 as interface x
```

**Note:** x is the assigned interface number.

**Note:** The 2216 has eight slots, numbered 1 to 8.

5. Enter the **network** command and the number of the interface you obtained in step 4. For example, if interface 0 is an ESCON interface:

```
Config> network 0
ESCON Config>
```

The ESCON configuration prompt (ESCON Config>), is displayed.

6. Configure the channel adapter virtual net handlers and associated subchannels using the commands in Table 52.

---

## Channel Adapter Configuration Commands

The following commands can be entered at a channel adapter configuration prompt (either ESC Config> or PCA Config>):

*Table 52. Channel Interface Configuration Commands*

Command	Description
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
add	<p>Adds a virtual net handler for one of the base protocols or adds APPN loopback :</p> <ul style="list-style-type: none"> <li>• LCS - LAN Channel Station Support</li> <li>• LSA - Link Services Architecture</li> <li>• MPC+ - Multi-Path Channel+</li> <li>• APPN loopback</li> </ul> <p>Each protocol provides a unique set of parameters which can be used to configure the virtual net handlers.</p>
delete	Deletes an interface on the channel adapter.
list	Lists the channel adapter configuration and optionally lists subchannels. You can also list the transfer mode and channel transfer speed for a PCA.
mod	Changes the configuration of an interface on the channel adapter.
set	<p>Sets the transfer mode and channel transfer speed for a parallel channel adapter (PCA).</p> <p><b>Note:</b> You can only access this command when configuring a PCA interface.</p>
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### Add

Use the **add** command to add virtual network handlers for LCS, LSA, and MPC+, and to enable loopback for APPN.

#### Syntax:

```
add lcs
lsa
mpc
```

## Channel Adapter Configuration Commands (Talk 6)

appn loopback

### Configuring an LCS Virtual Interface

Use the **add lcs** command to add an LCS virtual interface and get to the ESCON Add Virtual> or PCA Add Virtual> prompt from which you can enter other interface and subchannel parameters.

**Note:** Although LCS requires two subchannels, it is only necessary to specify one subchannel. An adjacent subchannel will be chosen such that the two subchannels will form a sequential pair with the write subchannel (device address is even) before the read subchannel (device address is odd).

After entering the **add lcs**, you will receive either the ESCON Add Virtual> or PCA Add Virtual> prompt. At this prompt you can enter the following commands:

Command	Description
---------	-------------

<u>acklen</u> <i>bytes</i>	The size (in bytes) of acknowledgment frames over this interface.
----------------------------	---

**Note:** The default value of 10 causes acknowledgment frames to be blocked. This value gives the best performance in heavy traffic networks if it is used with the default *blktimer* value. For IP interactive traffic and bulk data transfer, set **acklen** to 100.

**Valid values:** 1 to 500 bytes

**Default value:** 10

<u>blktimer</u> <i>milliseconds</i>	The maximum time (in milliseconds) to wait before sending an unfull data block to the host.
-------------------------------------	---

**Note:** The default value is set to give the best performance in heavy traffic networks. Set **blktimer** to 10 for IP interactive traffic and bulk data transfer.

**Valid values:** 1 to 20

**Default value:** 5

<u>lantype</u> <i>type</i>	LAN type, either Ethernet, Token Ring, or FDDI
----------------------------	--

**Example:** Specifying LAN Type for an LCS interface on an ESCON interface

```
ESCON Add Virtual>lan
Please select one of the following LAN types:
  E Ethernet
  T Token Ring
  F FDDI
LCS LAN Type: [E]?
```

<u>mac</u> <i>address</i>	MAC Address of the virtual net handler
---------------------------	--

<u>maxdata</u> <i>bytes</i>	Maximum size of data handled by this virtual network handler.
-----------------------------	---

**Valid Values:** 516 to 17749 for Token Ring, 1500 for Ethernet, 4478 for FDDI

**Default:** 2052 for Token Ring, 1500 for Ethernet, 4478 for FDDI

## Channel Adapter Configuration Commands (Talk 6)

### subchannels *command*

Places you at the next prompt based on the value of *command*. *Command* can be one of the following:

- add
- list
- mod

See “Configuring an LCS Subchannel” for the commands you can enter at these prompts and their description.

### enable 3172 emulation

Enables LCS Passthru to allow the device to function as a 3172 replacement in TCP/IP networks. When you enable 3172 emulation, you have the following menu available at the ESCON Add Virtual> command prompt:

```
ESCON Add Virtual>?  
BLKtimer  
ACKlen  
SUBchannels  
DISable 3172 Emulation  
NET link  
Exit  
ESCON Add Virtual>
```

See “3172 Emulation Using LCS Passthru” on page 363 for an example of 3172 emulation.

## Configuring an LCS Subchannel

Entering subchannels *command* places you at the next prompt based on the value of *command*. *Command* can be one of the following:

- add
- list
- mod
- exit

Command	Description
---------	-------------

<u>add</u>	Adds a subchannel pair and displays the ESCON Config LCS Subchannel> or PCA Config LCS Subchannel> prompt from which you can add Device Address, LPAR number, Link Address, and CU Logical Address.
------------	---

#### Notes:

1. You only need to specify the device address for PCA interfaces.
2. You must add or configure one subchannel for an LCS virtual interface. Although LCS requires two subchannels, it is only necessary to specify one subchannel. An adjacent subchannel will be chosen such that the two subchannels will form a sequential pair with the write subchannel (device address is even) before the read subchannel (device address is odd).

### device address

The unit address transmitted on the channel path to select a 2216 device. It is also referred to as subchannel number in S/370 I/O architecture. It is a two-digit hexadecimal value that can range from X'00' to X'FF'. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device.

**Valid Values:** X'00' to X'FF'

## Channel Adapter Configuration Commands (Talk 6)

**Default:** None

### **Important**

The following parameters do not apply for PCA.

#### lpar *number*

Logical partition number. This allows multiple logical host partitions (LPARs) to share one ESCON channel.

This value is defined in the host Input/Output Configuration Program (IOCP) by the RESOURCE macro instruction.

If the host is not using EMIF, use the default of 0 for the LPAR number.

**Valid Values:** X'0' - X'F'

**Default:** X'0'

#### link *address*

If one ESCON Director (ESCD) is in the communication path, the link address is the ESCD port number that is attached to the host.

If two ESCDs are in the path, it is the host-side port number of the ESCD defined with the dynamic connection.

When no ESCD is in the communication path, this value must be set to X'01'.

**Valid Values:** X'01' - X'0F'

**Default:** X'01'

#### cu *address*

The Control Unit address defined in the host for the 2216. This value is defined in the host Input/Output Configuration Program (IOCP) by the CUADD statement on the CNTLUNIT macro instruction.

**Valid Values:** X'0' - X'F'

**Default:** X'0'

**Example:** Adding a subchannel for an LCS interface for an ESCON interface

```
ESCON Add Virtual>sub add
Please add or configure one subchannel for an LCS virtual interface.
Although LCS requires two subchannels, it is only necessary to specify
one subchannel. An adjacent subchannel will be chosen such that the two
subchannels will form a sequential pair with the write subchannel (device
address is even) before the read subchannel (device address is odd).
ESCON Config LCS Subchannel>d 4
ESCON Config LCS Subchannel>e
```

#### list

Lists information for the LCS subchannels.

**Example:** Listing subchannels for an ESCON LCS interface

```
ESCON Add Virtual>sub Lis
Read Subchannels:
Sub 0 Device address : 5 LPAR number : 0
      Link address  : 1 CU Logical Address : 0
Write Subchannels:
Sub 1 Device address : 4 LPAR number : 0
      Link address  : 1 CU Logical Address : 0
```

**Example:** Listing subchannels for an PCA LCS interface

## Channel Adapter Configuration Commands (Talk 6)

```
PCA Add Virtual>sub 1is
Read Subchannels:
Sub 2 Device address : 3

Write Subchannels:
Sub 3 Device address : 2
```

**mod** Modifies a configured LCS subchannel pair. It lists the configuration for the configured LCS subchannels and allows you to modify one of them by specifying the “sub” number from the list. Once you have selected the subchannel, you can change the device address, LPAR number, Link Address, and CU Logical Address as described in “Configuring an LCS Subchannel” on page 382 .

### Notes:

1. You can only change the device address for PCA.
2. For ESCON or PCA, if there is only one subchannel configured, you can only modify the subchannel, not delete it.

## Configuring an LSA Virtual Interface

Use the **add lsa** command to add an LSA virtual interface and get to the ESCON Add Virtual> or PCA Add Virtual> prompt from which you can enter the following commands:

Command	Description
---------	-------------

<b>[enable or disable]</b>	
----------------------------	--

Enables or disables loopback on an LSA interface.

**Note:** Only **one** of these parameters can be entered, depending on the state of the loopback function. If the loopback is disabled, you can enable it; if it is enabled, you can disable it.

**Valid Values:** enable or disable

**Default:** disable

<b>acklen bytes</b>	The size (in bytes) of acknowledgment frames over this interface.
---------------------	---

**Note:** The default value of 10 causes acknowledgment frames to be blocked. This value gives the best performance in heavy traffic networks if it is used with the default blktimer value. Set **acklen** to 100 for IP bulk data transfer and interactive traffic.

**Valid values:** 1 to 500 bytes

**Default value:** 10

<b>blktimer milliseconds</b>	
------------------------------	--

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

**Note:** The default value is set to give the best performance in heavy traffic networks. Set **blktimer** to 10 for IP bulk data transfer and interactive traffic over Ethernet and token-ring LANs.

**Valid values:** 1 to 20

## Channel Adapter Configuration Commands (Talk 6)

**Default value:** 10

- lantype** *type* LAN type, either Ethernet, or Token-Ring.
- mac** *address* A unique MAC address to identify this virtual interface. This parameter is available only when loopback is enabled. It is the MAC address of the LSA/VTAM side of the loopback connection. The MAC address of the APPN side of the loopback connection is specified using ADD APPN.
- maxdata** *bytes* Maximum size of data handled by this virtual network handler.  
**Valid Values:** 516 to 17749 for Token Ring, 1500 for Ethernet  
**Default:** 2052 for Token Ring, 1500 for Ethernet
- net** *interface#* This parameter is available only when loopback is disabled. It is used to indicate the LAN adapter over which this LSA net will communicate. The LAN adapter must have been previously configured and can only be Token-Ring, Ethernet (including emulated LANs), or FDDI.
- subchannels** Places you at the next prompt based on the value of *command*. *Command* can be one of the following:
- add
  - delete
  - list
  - mod
- See "Configuring an LSA Subchannel" on page 386 for the commands you can enter at these prompts and their description.

There are four types of LSA connections, as shown in Figure 26 on page 365. They are:

- "Configuring an LSA Direct Connection at the 2216" on page 366
- "Configuring an LSA APPN Connection at the 2216" on page 367
- "Configuring an LSA DLSw Connection at the 2216" on page 368
- "Configuring an LSA DLSw Local Conversion at the 2216" on page 370

The example shows adding two LSA interfaces. The first one uses loopback and the second one is a direct connection.

### Example 1: Adding an ESCON LSA interface with loopback

```
ESCON Config>add lsa
ESCON Add Virtual>enable
Enabling loopback through network 2.
Please set the MAC address using the "MAC" command
ESCON Add Virtual>mac 40:00:00:00:22:16
ESCON Add Virtual>lan
Please select one of the following LAN types:
  E Ethernet
  T Token Ring
LSA LAN Type: [E]? e
ESCON Add Virtual>sub add
ESCON Add LSA Subchannel>link c5
ESCON Add LSA Subchannel>d 8
ESCON Add LSA Subchannel>e
ESCON Add Virtual>e
ESCON Config>list all
Net: 2 Protocol: LSA LAN type: LSA Ethernet LAN number: 0
Maxdata: 1500
Loopback is enabled.
```

## Channel Adapter Configuration Commands (Talk 6)

```
MAC address: 400000002216
Block timer: 10 ms ACK length: 10 bytes
Sub 0 Dev addr: 8 LPAR: 0 Link addr: C5 CU addr: 0
```

### Example 2: Adding a PCA LSA interface with direct connection

```
PCA Config>add 1sa
PCA Add Virtual>net 0
PCA Add Virtual>sub add
PCA Add LSA Subchannel>d 7
PCA Add LSA Subchannel>e
PCA Add Virtual>e
PCA Config>list all
Net: 6 Protocol: LSA LAN type: Token Ring LAN number: 0
Maxdata: 2052
Loopback is not enabled.
MAC address: Obtained from net 0
Block timer: 10 ms ACK length: 10 bytes
Sub 0 Dev addr: 7
PCA Config>
```

## Configuring an LSA Subchannel

Entering **subchannels** *command* places you at the next prompt based on the value of *command*. *Command* can be one of the following:

- add
- delete
- list
- mod
- exit

Command	Description
---------	-------------

<u>a</u> dd	Adds a subchannel and displays the ESCON Add LSA Subchannel> or PCA Add LSA Subchannel> prompt from which you can add:
-------------	--

<u>d</u> evice <i>address</i>	The unit address transmitted on the channel path to select a 2216 device. It is also referred to as subchannel number in S/370 I/O architecture. It is a two-digit hexadecimal value that may range from 00-FF. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device.
-------------------------------	--

**Valid Values:** X'00' to X'FF'

**Default:** None

<b>Important</b>
------------------

The following parameters do not apply for PCA.
--

<u>l</u> par <i>number</i>	Logical partition number. This allows multiple logical host partitions, (LPARs) to share one ESCON channel.
----------------------------	---

This value is defined in the host Input/Output Configuration Program (IOCP) by the RESOURCE macro instruction.

If the host is not using EMIF, use the default of 0 for the LPAR number.

**Valid Values:** X'0' - X'F'

**Default:** X'0'



## Channel Adapter Configuration Commands (Talk 6)

### link address

If one ESCON Director (ESCD) is in the communication path, the link address is the ESCD port number that is attached to the host.

If two ESCDs are in the path, it is the host-side port number of the ESCD defined with the dynamic connection.

When no ESCD is in the communication path, this value must be set to X'01'.

**Valid Values:** X'01' - X'FE'

**Default:** X'01'

### cu address

The Control Unit address defined in the host for the 2216. This value is defined in the host Input/Output Configuration Program (IOCP) by the CUADD statement on the CNTLUNIT macro instruction.

**Valid Values:** X'0' - X'F'

**Default:** X'0'

Enter **exit** to return to the previous prompt.

**Example:** Adding a subchannel for an ESCON LSA interface

```
ESCON Add Virtual>sub add
ESCON Add LSA Subchannel>link f7
ESCON Add LSA Subchannel>device 0
ESCON Add LSA Subchannel>cu 0
ESCON Add LSA Subchannel>lpar 0
ESCON Add LSA Subchannel>exit
```

**Example:** Adding a subchannel for a PCA LSA interface

```
PCA Add Virtual>sub add
PCA Add LSA Subchannel>device 2
PCA Add LSA Subchannel>exit
```

### delete

Deletes a configured LSA subchannel. It lists the configuration for the configured LSA subchannels and allows you to delete one of them by specifying the "sub" number from the list.

### list

Lists information for the LSA subchannels.

**Example:** Listing subchannels for an ESCON LSA interface

```
ESCON Config Virtual>sub list
Sub 0 Device address : 42 LPAR number : 0
      Link address   : C5 CU Logical Address : 0
Sub 1 Device address : 43 LPAR number : 0
      Link address   : C5 CU Logical Address : 0
Sub 2 Device address : 44 LPAR number : 0
      Link address   : C5 CU Logical Address : 0
```

**Example:** Listing subchannels for a PCA LSA interface

```
PCA Config Virtual>sub list
Sub 0 Device address : B
Sub 1 Device address : 12
Sub 2 Device address : 10
Sub 3 Device address : A
Sub 4 Device address : C
Sub 5 Device address : E
```

### mod

Modifies a configured LSA subchannel. It lists the configuration for the configured LSA subchannels and allows you to modify one of them by specifying the "sub" number from the list. Once you have selected the subchannel, you can change the device address,

## Channel Adapter Configuration Commands (Talk 6)

LPAR number, Link Address, and CU Logical Address as described in “Configuring an LSA Subchannel” on page 386.

### Notes:

1. You can only change the device address for PCA.
2. For ESCON or PCA, if there is only one subchannel configured, you can only modify the subchannel, not delete it.

### Configuring an MPC+ Virtual Interface

Use the **add mpc** command to add an MPC+ virtual interface and get to the ESCON Add Virtual> or PCA Add Virtual> prompt from which you can enter other interface and subchannel parameters:

Command	Description
---------	-------------

<b>acklen</b> <i>bytes</i>	The size (in bytes) of acknowledgment frames over this interface.
----------------------------	---

**Note:** The default value of 10 causes acknowledgment frames to be blocked. This value gives the best performance in heavy traffic networks if it is used with the default blktimer value.

**Valid values:** 1 to 500 bytes

**Default value:** 10

<b>blktimer</b> <i>milliseconds</i>	The maximum time (in milliseconds) to wait before sending an unfull data block to the host.
-------------------------------------	---

**Note:** The default value is set to give the best performance in heavy traffic networks.

**Valid values:** 1 to 20

**Default value:** 5

<b>disable_outbound_protocol_blocking</b>	Prevents the MPC+ Group from blocking multiple protocol packets within a single MPC+ packet when sending data to the host.
---	--

**Note:** This parameter affects UDP+ and TCP/IP traffic. Enabling this parameter gives better performance in heavy traffic networks. Enable is the default.

<b>disable_udp_exclusive_use</b>	To undedicate the MPC+ interface to UDP+.
----------------------------------	---

### Notes:

1. This parameter applies to ESCON interfaces only.
2. This means that only HPDT UDP in the host will be able to establish a connection across this MPC+ Group. UDP+ can never share an MPC+ Group with other protocols (for example, APPN, TCP/IP).

<b>enable_outbound_protocol_blocking</b>	Enables the MPC+ Group to block multiple protocol packets within a single MPC+ packet when sending data to the host.
--	--

## Channel Adapter Configuration Commands (Talk 6)

**Note:** This parameter affects UDP+ and TCP/IP traffic. Enabling this parameter gives better performance in heavy traffic networks. Enable is the default.

### enable udp+ exclusive use

To dedicate the MPC+ interface to UDP+.

#### **Notes:**

1. This parameter applies to ESCON interfaces only.
2. This means that only HPDT UDP in the host will be able to establish a connection across this MPC+ Group. UDP+ can never share an MPC+ Group with other protocols (for example, APPN, TCP/IP).

### maxdata bytes

Maximum size of data handled by this virtual network handler.

**Valid Values:** 512 to 32 768

**Default:** 2 048

### reply timeout milliseconds

Timer for XID2/Disconnect timeout in milliseconds.

**Valid Values:** 1 to 50 000

**Default:** 45 000

### sequencing interval timer milliseconds

Sequencing Interval Timer in milliseconds.

**Valid Values:** 1 to 50 000

**Default:** 3000

### subchannels

Places you at the next prompt based on the value of *command*. *Command* can be one of the following:

- addr
- addw
- delete
- list
- mod
- exit

See “Configuring an MPC+ Subchannel” for the commands you can enter and their description.

## Configuring an MPC+ Subchannel

**Note:** A subchannel defined as a read subchannel to VTAM is a write subchannel to the 2216 and a subchannel defined as a write subchannel to VTAM is a read subchannel to the 2216.

Entering subchannels *command* places you at the next prompt based on the value of *command*. *Command* can be one of the following:

- addr
- addw
- delete
- list
- mod
- exit

## Channel Adapter Configuration Commands (Talk 6)

Commands	Description
<u>addr</u>	Adds a read subchannel and displays the ESCON Add MPC+ Read Subchannel> or PCA Add MPC+ Read Subchannel> prompt from which you can enter the following commands:

Command	Description
---------	-------------

<u>device address</u>	<p>The unit address transmitted on the channel path to select a 2216 device. It is also referred to as subchannel number in S/370 I/O architecture. It is a two-digit hexadecimal value that may range from 00-FF. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device.</p> <p><b>Valid Values:</b> X'00' to X'FF'</p> <p><b>Default:</b> None</p>
-----------------------	--

**Important**

The following parameters do not apply for PCA.

<u>lpar number</u>	<p>Logical partition number. This allows multiple logical host partitions, (LPARs) to share one ESCON channel.</p> <p>This value is defined in the host Input/Output Configuration Program (IOCP) by the RESOURCE macro instruction.</p> <p>If the host is not using EMIF, use the default of 0 for the logical partition number.</p> <p><b>Valid Values:</b> X'0' - X'F'</p> <p><b>Default:</b> X'0'</p>
<u>link address</u>	<p>If one ESCON Directors (ESCD) is in the communication path, the link address is the ESCD port number that is attached to the host.</p> <p>If two ESCDs are in the path, it is the host-side port number of the ESCD defined with the dynamic connection.</p> <p>When no ESCD is in the communication path, this value must be set to X'01'.</p> <p><b>Valid Values:</b> X'01' - X'FE'</p> <p><b>Default:</b> X'01'</p>
<u>cu address</u>	<p>The Control Unit address defined in the host for the 2216. This value is defined in the host Input/Output Configuration Program (IOCP) by the CUADD statement on the CNTLUNIT macro instruction.</p> <p><b>Valid Values:</b> X'0' - X'F'</p> <p><b>Default:</b> X'0'</p>

## Channel Adapter Configuration Commands (Talk 6)

Enter **exit** to return to the ESCON Add Virtual> prompt.

**Example:** Adding read subchannels for a PCA MPC+ interface

```
PCA Add Virtual>sub addr
PCA Add MPC+ Read Subchannel>d 8
PCA Add MPC+ Read Subchannel>e
PCA Add Virtual>sub addr
PCA Add MPC+ Read Subchannel>d 9
PCA Add MPC+ Read Subchannel>e
```

### addw

Adds a write subchannel and displays the ESCON Add MPC+ Write Subchannel> or PCA Add MPC+ Write Subchannel> prompt from which you can enter the following commands:

#### **Command**      **Description**

##### device address

The unit address transmitted on the channel path to select a 2216 device. It is also referred to as subchannel number in S/370 I/O architecture. It is a two-digit hexadecimal value that may range from 00-FF. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device.

**Valid Values:** X'00' to X'FF'

**Default:** None

#### **Important**

The following parameters do not apply for PCA.

##### lpar number

Logical partition number. This allows multiple logical host partitions, (LPARs) to share one ESCON channel.

This value is defined in the host Input/Output Configuration Program (IOCP) by the RESOURCE macro instruction.

If the host is not using EMIF, use the default of 0 for the LPAR number.

**Valid Values:** X'0' - X'F'

**Default:** X'0'

##### link address

If one ESCON Director (ESCD) is in the communication path, the link address is the ESCD port number that is attached to the host.

If two ESCDs are in the path, it is the host-side port number of the ESCD defined with the dynamic connection.

When no ESCD is in the communication path, this value must be set to X'01'.

**Valid Values:** X'01' - X'FE'

**Default:** X'01'

##### cu address

The Control Unit address defined in the host for the 2216. This value is defined in the host Input/Output

## Channel Adapter Configuration Commands (Talk 6)

Configuration Program (IOCP) by the CUADD statement on the CNTLUNIT macro instruction.

The Control Unit Address must be unique for each logical partition defined on the same host.

**Valid Values:** X'0' - X'F'

**Default:** X'0'

**Example:** Adding write subchannels for an ESCON MPC+ interface

```
ESCON Add Virtual>sub addw
ESCON Add MPC+ Write Subchannel>d 10
ESCON Add MPC+ Write Subchannel>e
ESCON Add Virtual>sub addw
ESCON Add MPC+ Write Subchannel>d 11
ESCON Add MPC+ Write Subchannel>e
```

### delete

Deletes a configured MPC+ subchannel. It lists the configuration for the configured MPC+ subchannels and allows you to delete one of them by specifying the "sub" number from the list.

### list

Lists information for the MPC+ subchannels.

**Example:** Listing subchannels for an ESCON MPC+ interface

```
ESCON Add Virtual>sub lis
Read Subchannels:
Sub 0 Device address : 8 LPAR number : 0
      Link address  : 1 CU Logical Address : 0
Sub 1 Device address : 9 LPAR number : 0
      Link address  : 1 CU Logical Address : 0
Write Subchannels:
Sub 2 Device address : 10 LPAR number : 0
      Link address  : 1 CU Logical Address : 0
Sub 3 Device address : 11 LPAR number : 0
      Link address  : 1 CU Logical Address : 0
```

**Example:** Listing subchannels for a PCA MPC+ interface

```
PCA Add Virtual>sub lis
Read Subchannels:
Sub 0 Device address : 12
Sub 1 Device address : 13
Write Subchannels:
Sub 2 Device address : 14
Sub 3 Device address : 15
```

### mod

Modifies a configured MPC+ subchannel. It lists the configuration for the configured MPC+ subchannels and allows you to modify one of them by specifying the "sub" number from the list. Once you have selected the subchannel, you can change the device address, LPAR number, Link Address, and CU Logical Address as described in "Configuring an MPC+ Subchannel" on page 389 .

**Note:** You can only change the device address for PCA.

Once you have returned to the previous prompt, you can list the entire MPC+ configuration as shown in the following example:

**Example:** Listing and changing an ESCON MPC+ configuration

```
ESCON Config>list all
Net: 1 Protocol: MPC+ LAN type: MPC+ LAN number: 0
Maxdata: 2048
Reply TO: 45000 Sequencing Interval Timer: 3000
MPC Group is for exclusive use of UDP+
Outbound protocol data blocking is enabled
Block timer: 5 ms ACK Length: 10 bytes
Read Subchannels:
Sub 0 Dev addr: 40 LPAR: 0 Link addr: F5 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 41 LPAR: 0 Link addr: F5 CU addr: 0
```

## Channel Adapter Configuration Commands (Talk 6)

```
Net: 2 Protocol: MPC+ LAN type: MPC+ LAN number: 1
Maxdata: 2048
Reply TO: 45000 Sequencing Interval Timer: 3000
Outbound protocol data blocking is enabled
Block timer: 5 ms ACK Length: 10 bytes
Read Subchannels:
Sub 0 Dev addr: 42 LPAR: 0 Link addr: F5 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 43 LPAR: 0 Link addr: F5 CU addr: 0

Net: 3 Protocol: MPC+ LAN type: MPC+ LAN number: 2
Maxdata: 2048
Reply TO: 45000 Sequencing Interval Timer: 3000
Outbound protocol data blocking is enabled
Block timer: 5 ms ACK Length: 10 bytes
Read Subchannels:
Sub 0 Dev addr: 44 LPAR: 0 Link addr: F5 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 45 LPAR: 0 Link addr: F5 CU addr: 0
```

```
ESCON Config>mod 3
ESCON Config Virtual>?
REply timeout
SEQuencing int timer
MAXdata
SUBchannels
Exit
ESCON Config Virtual>rep 3100
ESCON Config Virtual>exit
ESCON Config>list all
```

```
Net: 1 Protocol: MPC+ LAN type: MPC+ LAN number: 0
Maxdata: 2048
Reply TO: 45000 Sequencing Interval Timer: 3000
MPC Group is for exclusive use of UDP+
Outbound protocol data blocking is enabled
Block timer: 5 ms ACK Length: 10 bytes
Read Subchannels:
Sub 0 Dev addr: 40 LPAR: 0 Link addr: F5 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 41 LPAR: 0 Link addr: F5 CU addr: 0

Net: 2 Protocol: MPC+ LAN type: MPC+ LAN number: 1
Maxdata: 2048
Reply TO: 45000 Sequencing Interval Timer: 3000
Outbound protocol data blocking is enabled
Block timer: 5 ms ACK Length: 10 bytes
Read Subchannels:
Sub 0 Dev addr: 42 LPAR: 0 Link addr: F5 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 43 LPAR: 0 Link addr: F5 CU addr: 0

Net: 3 Protocol: MPC+ LAN type: MPC+ LAN number: 2
Maxdata: 2048
Reply TO: 3100 Sequencing Interval Timer: 3000
Outbound protocol data blocking is enabled
Block timer: 5 ms ACK Length: 10 bytes
Read Subchannels:
Sub 0 Dev addr: 44 LPAR: 0 Link addr: F5 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 45 LPAR: 0 Link addr: F5 CU addr: 0
```

```
ESCON Config>
```

## Configuring APPN Loopback

**Important:** You only need to configure APPN loopback once for each physical 2216. If you configure APPN loopback on an ESCON channel, you do not need to enable it on a PCA channel in the same 2216.

### Notes:

1. APPN loopback cannot be added unless loopback has been enabled on an LSA virtual net as described in “Configuring an LSA Virtual Interface” on page 384.
2. You can only add APPN loopback once on a given IBM 2216.

## Channel Adapter Configuration Commands (Talk 6)

Use the **add appn** command to add APPN loopback. You will get either the ESCON Add Virtual> or PCA Add Virtual> prompt where you can enter the following commands:

Commands	Description
<u>lantype</u> <i>type</i>	Ethernet or Token Ring
<u>mac</u> <i>address</i>	A unique MAC address to identify the APPN side of the loopback connection in the 2216. This address must be different from the MAC address given to the host (VTAM) side of the loopback connection when configuring the LSA interface.

### Example: Adding APPN loopback to an ESCON interface

```
ESCON Config>add appn
ESCON Add Virtual>
ESCON Add Virtual>lan
Please select one of the following LAN types:
  E Ethernet
  T Token Ring
APPN LAN Type: [T]?
ESCON Add Virtual>mac
MAC address in 00:00:00:00:00:00 form [000000000000]?
  40:00:22:16:00:09
ESCON Add Virtual>e
ESCON Config>1i a11
Net: 9 Protocol: APPN Loopback LAN type: Token-Ring/802.5
      APPN loopback MAC address: 400022160009

Net: 5 Protocol: LSA LAN type: Token Ring LAN number: 0
      Maxdata: 2052
      Loopback is enabled.
      MAC address: 400022160005
      Block timer: 10 ms ACK length: 10 bytes
      Sub 0 Dev addr: 0 LPAR: 0 Link addr: 1 CU num: 0

Net: 6 Protocol: LSA LAN type: Token Ring LAN number: 1
      Maxdata: 2052
      Loopback is not enabled.
      MAC address: Obtained from net 3
      Block timer: 10 ms ACK length: 10 bytes
      Sub 0 Dev addr: 1 LPAR: 0 Link addr: 1 CU num: 0

Net: 7 Protocol: LCS LAN type: LCS Ethernet 802.3 LAN number: 0
      Maxdata: 1500
      MAC address: 400022160007
      Block timer: 5 ms ACK length: 10 bytes
      Read Subchannels:
      Sub 0 Dev addr: 5 LPAR: 0 Link addr: 1 CU num: 0
      Write Subchannels:
      Sub 1 Dev addr: 4 LPAR: 0 Link addr: 1 CU num: 0
ESCON Config>e
```

### Notes:

1. The APPN port would be configured on net 9 of the example.
2. Configure APPN link stations that will connect to VTAM over the ESCON channel to use the MAC address of the LSA net as the destination MAC address. Do not use the APPN loopback net for this purpose.
3. Any LSA nets connection to APPN must have the same LAN type as the APPN loopback net.

## Delete

Use the **delete** command to delete an interface on the channel adapter. If you know the interface number you wish to delete, you can specify it; otherwise, if you do not enter an interface number, the configuration is listed and you will be prompted to enter an interface number.

### Syntax:



## Channel Adapter Configuration Commands (Talk 6)

**delete** *interface\_number*  
(no parameter)

**interface\_number**  
Deletes the configuration for the specified interface number.

**(no parameters)**  
Lists the configured interfaces for the channel adapter and prompts you for the interface number you wish to delete.

**Example:** Deleting an interface (no parameters given)

```
PCA Config>del
Net: 5 Protocol: APPN Loopback LAN type: Token-Ring/802.5
      APPN loopback MAC address: 400000000406
Net: 2 Protocol: LSA LAN type: Token Ring LAN number: 0
      Maxdata: 2052
      Loopback is enabled.
      MAC address: 400000000403
      Block Timer: 10 ms ACK length: 10 bytes
Net: 3 Protocol: LSA LAN type: Token Ring LAN number: 1
      Maxdata: 2052
      Loopback is not enabled.
      MAC address: Obtained from net 1
      Block Timer: 10 ms ACK length: 10 bytes
Net: 4 Protocol: MPC+ LAN type: MPC+ LAN number: 0
      Maxdata: 2048
      Reply TO: 3100 Sequencing Interval Timer: 3000
      Outbound protocol data blocking is enabled
      Block Timer: 5 ms ACK length: 10 bytes
Virtual net number to delete: [2]? 3
Are you sure?(Yes or [No]): y
```

## Mod

Use the **mod** command to modify a configured interface on the channel adapter. If you know the interface number you wish to modify, you can specify it; otherwise, if you do not enter an interface number, the configuration is listed and you will be prompted to enter an interface number.

**Syntax:**

**modify** *interface\_number*  
(no parameters)

**interface\_number**  
Modifies the configuration for the specified interface number.

**(no parameters)**  
Lists the configured interfaces for the channel adapter and prompts you for the interface number you wish to modify.

**Example:**

## Channel Adapter Configuration Commands (Talk 6)

```
ESCON Config> mod
Net: 1 Protocol: MPC+ LAN type: MPC+ LAN number: 0
      Maxdata: 2048
      Reply TO: 45000 Sequencing Interval Timer: 3000
      MPC Group is for exclusive use of UDP+
      Outbound protocol data blocking is enabled
      Block timer: 5 ms ACK length: 10 bytes
Net: 2 Protocol: MPC+ LAN type: MPC+ LAN number: 1
      Maxdata: 2048
      Reply TO: 45000 Sequencing Interval Timer: 3000
      Outbound protocol data blocking is enabled
      Block timer: 5 ms ACK length: 10 bytes
Virtual net number to configure: [1]? 2
ESCON Config Virtual> ?
REply timeout
SEQuencing int timer
MAXdata
SUBchannels
Exit
ESCON Config Virtual>re
Reply Time Out (range 1-50000 milliseconds): [45000]? 30003
ESCON Config Virtual>sub list
  Read Subchannels:
    Sub 0 Device address : 7 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
  Write Subchannels:
    Sub 1 Device address : 6 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
ESCON Config Virtual>sub addr
ESCON Add MPC+ Read Subchannel> ?
LINK address (ESCD Port)
LPAR number
CU logical address
Device address
Exit
ESCON Add MPC+ Read Subchannel>d 5
ESCON Add MPC+ Read Subchannel>? e
ESCON Config Virtual>sub list
  Read Subchannels:
    Sub 0 Device address : 7 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
    Sub 1 Device address : 5 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
  Write Subchannels:
    Sub 2 Device address : 6 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
ESCON Config Virtual>sub ?
ADDRead subchannel
ADDWrite subchannel
MODify subchannel
DELEte subchannel
LIst subchannels
ESCON Config Virtual>sub del
  Read Subchannels:
    Sub 0 Device address : 7 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
    Sub 1 Device address : 5 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
  Write Subchannels:
    Sub 2 Device address : 6 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
Subchannel number to delete: [0]? 0
Are you sure?(Yes or [No]): y
ESCON Config Virtual>sub list
  Read Subchannels:
    Sub 0 Device address : 5 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
  Write Subchannels:
    Sub 1 Device address : 6 LPAR number : 0
          Link address  : F4 CU Logical Address : 0
```

## Channel Adapter Configuration Commands (Talk 6)

```
ESCON Config Virtual>sub mod
  Read Subchannels:
    Sub 0 Device address : 5 LPAR number : 0
      Link address : F4 CU Logical Address : 0
  Write Subchannels:
    Sub 1 Device address : 6 LPAR number : 0
      Link address : F4 CU Logical Address : 0
Subchannel number to modify: [0]? 1
ESCON Modify MPC+ Subchannel>d 2
ESCON Modify MPC+ Subchannel>e
ESCON Config Virtual>sub list
  Read Subchannels:
    Sub 0 Device address : 5 LPAR number : 0
      Link address : F4 CU Logical Address : 0
  Write Subchannels:
    Sub 1 Device address : 2 LPAR number : 0
      Link address : F4 CU Logical Address : 0
ESCON Config Virtual> exit
ESCON Config>
```

## List (ESCON)

Use the **list** command to list the channel adapter configuration and also (with **list all**) list a subchannel summary.

### Syntax:

```
list (no parameters)
all
```

### (no parameters)

Lists the channel adapter configuration.

#### Example: Listing an ESCON configuration

```
ESCON Config>li
Net: 5 Protocol: LSA LAN type: Token Ring LAN number: 0
Maxdata: 2052
Loopback is enabled.
MAC address: 400022160005
Block timer: 10 ms ACK length: 10 bytes
```

**all** Lists the channel configuration with a subchannel summary. Three examples are provided. The first is for a channel adapter with LSA and LCS subchannels. The second is for a channel adapter with MPC+ subchannels. The third example show the results of 3172 Emulation.

#### Example for LSA and LCS: Listing an ESCON configuration with subchannel summary

```
ESCON Config>li all
Net: 2 Protocol: LCS LAN type: LCS FDDI LAN number: 0
Maxdata: 4478
MAC address: 400000002216
Block Timer: 5 ms ACK Length: 10 bytes
Sub 0 Dev addr: 8 LPAR: 0 Link addr: C5 CU addr: 0

Net: 5 Protocol: LSA LAN type: Token Ring LAN number: 0
Maxdata: 2052
Loopback is enabled.
MAC address: 400022160005
Block timer: 10 ms ACK length: 10 bytes
Sub 0 Dev addr: 0 LPAR: 0 Link addr: 1 CU addr: 0
```

#### Example with 3172 Emulation enabled:

```
ESCON Config>list
Net: 5 Protocol: LCS LAN type: Token Ring LAN number: 0
3172 Emulation is enabled.
MAC address: Obtained from net 0
Block Timer: 5 ms ACK length: 10 bytes
ESCON Config>list all
Net: 5 Protocol: LCS LAN type: Token Ring LAN number: 0
3172 Emulation is enabled.
MAC address: Obtained from net 0
Block Timer: 5 ms ACK length: 10 bytes
```

## Channel Adapter Configuration Commands (Talk 6)

```
Read Subchannels:
Sub 0 Dev addr: 21 LPAR: 0 Link addr: F7 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 20 LPAR: 0 Link addr: F7 CU addr: 0
```

ESCON Config>

### Example for MPC+: Listing an ESCON configuration with subchannel summary

```
Net: 1 Protocol: MPC+ LAN type: MPC+ LAN number: 0
Maxdata: 2048
Reply TO: 45000 Sequencing Interval Timer: 3000
MPC Group is for exclusive use of UDP+
Outbound protocol data blocking is enabled
Block Timer: 5 ms ACK Length: 10 bytes
Read Subchannels:
Sub 0 Dev addr: 40 LPAR: 0 Link addr: F5 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 41 LPAR: 0 Link addr: F5 CU addr: 0

Net: 2 Protocol: MPC+ LAN type: MPC+ LAN number: 1
Maxdata: 2048
Reply TO: 45000 Sequencing Interval Timer: 3000
Outbound protocol data blocking is enabled
Block Timer: 5 ms ACK Length: 10 bytes
Read Subchannels:
Sub 0 Dev addr: 42 LPAR: 0 Link addr: F5 CU addr: 0
Write Subchannels:
Sub 1 Dev addr: 43 LPAR: 0 Link addr: F5 CU addr: 0
```

## List (PCA)

Use the **list** command to list the transfer mode and channel transfer speed configured or the virtual interfaces configured.

### Syntax:

```
list base
virtual
```

**base** Lists the transfer mode and channel transfer speed configured.

### **virtual [all or (no parameter)]**

Lists a summary of the configuration for the virtual interfaces or the configuration of all virtual interfaces and their subchannels (**all**).

## Set (PCA Only)

Use the **set** command to set the transfer mode and channel transfer speed for a parallel channel adapter (PCA).

### Syntax:

```
set tmode value
```

### **tmode value**

Specifies the mode of transfer that the 2216 uses to transfer data to the host, either DC interlock or Data Streaming and the channel transfer speed when using data streaming.

### Valid values:

- D** Specifies Direct-coupled (DC) Interlock mode. This mode is the standard I/O interface that requires a response to a demand.
- S** Specifies speeds less than or equal to a 3.0 MB data streaming mode.

## Channel Adapter Configuration Commands (Talk 6)

- S4** Specifies speeds less than or equal to a 4.5 MB data streaming mode.

**Default value:** D

---

### Accessing the Channel Interface Monitoring Process

To access the ESCON or PCA interface:

1. At the OPCON prompt, enter **talk 5**. For example:

```
* talk 5
+
```

2. To display the monitoring prompt for the channel interface or any of the channel adapter's virtual interfaces, enter the **network** command followed by the interface number of the interface.

If you do not know the interface number, use the **configuration** command at the + prompt to display a list of interface numbers configured on the router.

```
Multiprotocol Access Services

2216-MAS Feature 2822 V3.2 Mod 0 PTF 0 RPQ 0 MAS.EF9 cc4_2a

Num Name Protocol
0 IP DOD-IP
3 ARP Address Resolution
11 SNMP Simple Network Management Protocol
23 ASRT Adaptive Source Routing Transparent Enhanced Bridge
28 APPN Advanced Peer-to-Peer Networking [HPR]
29 NHRP Next Hop Routing Protocol
30 APPN Advanced Peer-to-Peer Networking [ISR]

Num Name Feature
2 MCF MAC Filtering
8 NDR Network Dispatching Router
10 AUTH Authentication

31 Networks:
Net Interface MAC/Data-Link Hardware State
0 TKR/0 Token-Ring/802.5 Token-Ring Up
1 Eth/0 Ethernet/IEEE 802.3 Ethernet Up
2 PCA/0 Parallel Channel Parallel Channel Up
3 LCS/0 LCS Parallel Channel Up
4 MPC/0 MPC Parallel Channel Up
5 LSA/0 LSA Parallel Channel Up
6 TKR/1 Token-Ring/802.5 APPN Loopback Up
7 ESCON/0 ESCON ESCON Channel Up
8 MPC/1 MPC ESCON Channel Up
9 LCS/1 LCS ESCON Channel Up
10 LSA/1 LSA ESCON Channel Up
```

---

### Channel Interface Monitoring Commands

The following commands can be entered at the channel adapter monitoring prompt (ESCON> or PCA>):

*Table 53. Channel Interface Monitoring Commands*

Command	Description
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
List	Lists subchannels or lists nets.
Net	Lists a specific network interface.
Dump_adapter	Non-disruptively takes a dump of the channel adapter's IRAM and DRAM.
HIDtrace	For PCA only, toggle off and on the channel adapter's HID (i.e. AIB) trace.
Trace	Turn off and on the various channel adapter microcode traces.
Tune	Modify various base network handler parameters.

## Channel Interface Monitoring Commands (Talk 5)

Table 53. Channel Interface Monitoring Commands (continued)

Command	Description
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

## List

Use the **list** command to list all subchannels or to list all network interfaces. You can also list the speed of a PCA interface.

### Syntax:

**list** base (PCA only)  
nets  
subchannels

**base** Lists the transfer mode and channel transfer speed of the channel adapter.

**nets** Lists network interfaces.

### Example: List networks

```
PCA>li ne
+ net 1
PCA Base Monitoring
PCA> li nets
Net: 2 Type: LSA LAN Type: Token-Ring/802.5 LAN Number: 0
      Net state: Up
Net: 4 Type: LSA LAN Type: Token-Ring/802.5 LAN Number: 1
      Net state: Up
Net: 5 Type: LCS LAN Type: FDDI LAN Number: 0
      Net state: Down
```

**Type** Type of virtual interface: LCS, LSA, or MPC+

### LAN Type

LAN type, either Token-Ring/802.5, Ethernet/802.3, Ethernet/V2, Ethernet or FDDI.

**Note:** This field is not displayed for subchannels that are part of an MPC+ interface.

### LAN Number

Interface number of the LAN

**Note:** This field is not displayed for subchannels that are part of an MPC+ interface.

### Group Number

The group number is used internally by the device to identify a virtual MPC+ net interface on the channel adapter.

### Net State

State of the network: Up, Down, Disabled, Not Present, HW Mismatch, or Testing.

**Up** Indicates that the link is up.

**Down** Indicates that the link is down.

### Disabled

Indicates that the operator has disabled the link.

### Not Present

Indicates that the network interface's adapter is not present.

## Channel Interface Monitoring Commands (Talk 5)

### HW Mismatch

An adapter other than a channel adapter is located in the slot or the physical channel adapter installed is not the same type as the configured channel adapter.

**Note:** Only base nets will have the states "Not present" and "HW mismatch."

### Testing

The system is attempting to determine if a network connection exists

### subchannels

Lists subchannels

```
ESCON> li su
The following subchannels are defined:
  Local address: 00   Device address: 00   CU Logical Address: 00
                    Link: C5   LPAR: 00
                    Type: LSA
    The following lantypes/lannums are using this subchannel:
                    LAN type: Token-Ring/802.5 LAN number: 0
  Local address: 01   Device address: DD   CU Logical Address: 0B
                    Link: 5C   LPAR: 02
                    Type: LSA
    The following lantypes/lannums are using this subchannel:
                    LAN type: Token-Ring/802.5 LAN number: 0
  Local address: 02   Device address: 07   CU Logical Address: 00
                    Link: C5   LPAR: 00
                    Type: LSA
    The following lantypes/lannums are using this subchannel:
                    LAN type: Token-Ring/802.5 LAN number: 1
  Local address: 03   Device address: 02   CU Logical Address: 00
                    Link: C5   LPAR: 00
                    Type: LCS
    The following lantypes/lannums are using this subchannel:
                    LAN type: FDDI   LAN number: 0
  Local address: 04   Device address: 03   CU Logical Address: 00
                    Link: C5   LPAR: 00
                    Type: LCS
    The following lantypes/lannums are using this subchannel:
                    LAN type: FDDI   LAN number: 0
```

### Local Address

The subchannel address index used internally by the device.

### Device Address

The unit address transmitted on the channel path to select a device. It is also referred to as subchannel number in S/370 I/O architecture. It is a two-digit hexadecimal value that may range from X'00' to X'FF'. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device.

**Note:** CU Logical Address, Link Address, and LPAR are only displayed for ESCON adapters.

### CU Logical Address

The Control Unit address defined in the host for the device. This value is defined in the host Input/Output Configuration Program (IOCP) by the CUADD statement on the CNTLUNIT macro instruction.

The Control Unit Address must be unique for each LPAR defined on the same host.

### Link Address

If one ESCON Director (ESCD) is in the communication path, the link address is the ESCD port number that is attached to the host.

## Channel Interface Monitoring Commands (Talk 5)

If two ESCDs are in the path, the link address is the host-side port number of the ESCD defined with the dynamic connection.

When no ESCD is in the communication path, this value must be set to 0x01.

**LPAR** Logical partition number. This allows multiple partitions in a logically partitioned (LPAR) host to share one ESCON fiber.

This value is defined in the host Input/Output Configuration Program (IOCP) by the RESOURCE macro instruction.

If the host is not using EMIF, the LPAR number is 0 (zero).

**Type** Type of virtual interface: LCS, LSA, or MPC+

### LAN Type

LAN type, either Token-Ring/802.5, Ethernet/802.3, Ethernet/V2, Ethernet or FDDI.

**Note:** This field is not displayed for subchannels that are part of an MPC+ interface.

### LAN Number

Interface number of the LAN

**Note:** This field is not displayed for subchannels that are part of an MPC+ interface.

### Group Number

The group number is used internally by the device to identify a virtual MPC+ net interface on the channel adapter.

## Net

Use the **net** command to get to the monitoring environment for one of the virtual interfaces as described in:

- “Channel Adapter LCS Interface Monitoring Commands” on page 403
- “Channel Adapter LSA Interface Monitoring Commands” on page 406
- “Channel Adapter MPC+ Interface Monitoring Commands” on page 408

### Syntax:

net *net\_number*

## Dump\_adapter

Use the **dump\_adapter** command to non-disruptively dump the channel adapter's IRAM and DRAM.

### Syntax:

dump\_adapter

## HIDTrace

For PCA only, use the **hidtrace** command to toggle off and on the channel adapter's HID(i.e. AIB) trace.

### Syntax:

hidtrace



## Trace

Use the **trace** command to turn off and on various channel adapter microcode traces.

**Syntax:**

**trace** mask

**mask** A valid trace mask.

**Valid Values:** X'0000' to X'FFFF'

**Default Values:** Will prompt for the input value

**Note:** X'FFFF' turns on all the traces. X'0000' turns off all the traces.

## Tune

Use the **tune** command to modify various base network handler parameters.

**Syntax:**

**tune** iplow  
opfair

**iplow** The low water mark for flow control of the network handler's input queue. See the GWCON queue command for more details.

**Valid Values:** 0 to 255

**Default Values:** Will prompt for the input value

**Note:** The network handler must be down or disabled in order to update this field.

**opfair** The fair level for the length of the network handler's output queue. See the GWCON queue command for more details.

**Valid Values:** 0 to 255

**Default Values:** Will prompt for the input value

**Note:** The network handler must be down or disabled in order to update this field.

---

## Channel Adapter LCS Interface Monitoring Commands

The following commands can be entered at the LCS monitoring prompt (LCS>):

*Table 54. Channel Adapter LCS Interface Monitoring Commands*

Command	Description
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
List	Lists subchannels or lists nets.
Tune	Modify various LCS network handler parameters.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

## Channel Interface Monitoring Commands (Talk 5)

### List

Use the **list** command to display information for an LCS interface.

#### Syntax:

**list**

#### Example:

```
LCS> list
LCS Virtual Adapter
LCS Information for Net 4
-----
LAN Type: Token-Ring/802.5      LAN Number: 0
Local Read Subchannel number: 7
Local Write Subchannel number: 6
MAC Address: 400022160001
Local IP Address: 9.192.200.1
Tuning Information: ACKLEN= 10, BLKTIMER= 5
Status: Down
```

#### Example with 3172 Emulation enabled

```
LCS> list

LCS Virtual Adapter
LCS Information for Net 5
-----
LAN Type: Token-Ring          LAN Number: 0
Local Read Subchannel number: 1
Local Write Subchannel number: 0
MAC Address: 08005AFE0144
LCS 3172 Emulation to net 0
Tuning Information: ACKLEN= 10, BLKTIMER= 5
Status: Down
```

#### LAN Type

LAN type, either Token-Ring/802.5, Ethernet/802.3, Ethernet/V2, Ethernet or FDDI.

**Note:** This field is not displayed for subchannels that are part of an MPC+ interface.

#### LAN Number

Interface number of the LAN

**Note:** This field is not displayed for subchannels that are part of an MPC+ interface.

#### Read Subchannel

The local subchannel from which the device receives data.

#### Write Subchannel

The local subchannel through which the device transmits data.

#### MAC Address

A unique MAC address to identify this virtual interface.

#### Local IP address

IP Address that was assigned to this network interface. If you have not configured an IP address, this line will not be displayed.

#### LCS Bridging

This is only displayed when bridging is configured. (Not shown in the example.)

## Channel Interface Monitoring Commands (Talk 5)

### Acklen

The size (in bytes) of acknowledgment frames over this network interface.

### Blktimer

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

### Status

Status of the network: Up, Down, Disabled, Not Present, HW Mismatch, or Testing

**Up** The network connection is established.

**Down** The network connection can not be determined.

### Disabled

Device is disabled and diagnostic testing can be performed

### Not Present

Indicates that the network interface's adapter is not present.

### HW Mismatch

An adapter other than a channel adapter is located in the slot or the physical channel adapter installed is not the same type as the configured channel adapter.

**Note:** Only base nets will have the states "Not present" and "HW mismatch."

### Testing

The system is attempting to determine if a network connection exists

## Tune

Use the **tune** command to modify various LCS network handler parameters.

### Syntax:

```
tune                acklen  
                    blktimer
```

### acklen

The size (in bytes) of acknowledgment frames over this LCS network interface.

**Valid Values:** 0 to 500

**Default Values:** Will prompt for the input value

**Note:** The base network handler with which the LCS network handler is associated must be up in order to modify this field.

### blktimer

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

**Valid Values:** 0 to 20

**Default Values:** Will prompt for the input value

**Note:** The base network handler with which the LCS network handler is associated must be up in order to modify this field.

## Channel Adapter LSA Interface Monitoring Commands

The following commands can be entered at the LSA monitoring prompt (LSA>):

Table 55. Channel Adapter LSA Interface Monitoring Commands

Command	Description
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
List	Lists information for adapters, SAPs, or link stations.
Tune	Modify various LSA network handler parameters.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### List

Use the **list** command to display information for adapters, SAPs, and link stations.

#### Syntax:

```
list                adapter
                   sap
                   link stations
```

#### adapter

Lists virtual adapters for LSA.

#### Example: List Virtual Adapter for LSA

```
LSA> list ad
LSA Virtual Adapter
LSA Information for Net 2
-----
LAN Type: Token-Ring/802.5      LAN Number: 0
MAC Address: 4000000000CF
Downstream network: Loopback - Net 2
Tuning Information: ACKLEN= 10, BLKTIMER= 10
Status: Host connected

#SAPs Open: 1      #Link Stations Open: 1
Maximum frame size: 2052 (0x804)
Host User ID      Subchannel
-----
00000000          0

1 host user(s)
```

#### Acklen

The size (in bytes) of acknowledgment frames over this network interface.

#### Blktimer

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

#### #SAPs Open

Number of SAPs opened by VTAM on this LSA interface

#### #Link Stations Open

Number of link stations open for all SAPs on this LSA interface

#### Maximum Frame Size

Maximum frame size supported over this LSA interface

## Channel Interface Monitoring Commands (Talk 5)

### Host User ID

A unique ID generated by VTAM to identify the host user on a given subchannel

### Subchannel

The local subchannel being used by this host user.

**sap** Lists Service Access Points (SAPS) for LSA

#### Example: List SAP for LSA

```
LSA> list sap
SAP    Provider    User    Max Link    Open Link
Number  SAP ID          SAP ID  Stations    Stations
-----  -
4      02000000      00000001  1          1
1 SAPs currently open
```

### SAP Number

Identifies the SAP to LLC

### Provider SAP ID

A unique ID generated by VTAM to identify this SAP

### User SAP ID

A unique ID generated by device to identify this SAP

### Max Link Stations

Maximum number of link stations VTAM can open on this SAP

### Open Link Stations

Number of link stations currently open on this SAP

**link** Lists link information for LSA

#### Example: List link for LSA

```
LSA> list link
Please specify a SAP number (0-236): [4]? 4
Link Stations on SAP 4

Station ID    Destination MAC Address    Destination SAP Number    Link Status    Frames Sent    Frames Received
-----  -
02000001    40000000ABCD                4                Connected        9                9
1 link station(s) open on SAP 4
```

### Station ID

A unique ID generated by device to identify this link station

### Destination MAC Address

MAC address of the remote LLC link station

### Destination SAP Number

SAP value of the remote LLC link station

### Link Status

Current status of the LLC connection

### Frames Sent

Number of packets sent to VTAM for this link station

### Frames Received

Number of packets received from VTAM for this link station

## Tune

Use the **tune** command to modify various LSA network handler parameters.

### Syntax:



## Channel Interface Monitoring Commands (Talk 5)

### Pending Active-waiting for this side

The other side has initiated bring-up of the CM but this side has not started to initiate bring-up of the CM.

### Pending Active-waiting for other side

This side has initiated bring-up of the CM but the other side has not started to initiate bring-up of the CM.

### Pending Active-callee

This side is waiting for the other side, which is the caller in this bring-up to start the call.

### Pending Active-caller

This side has called out to the other side and is waiting for the other side to respond to the call.

**Active** Active and usable

**Example:** List an active CM for MPC+

```
MPC+>1i cm
MPC+ Connection Managers(CM)
-----
Group Token      type      state
-----
09014495340000009      PTP      Active
```

**Example:** List, no active CM for MPC+

```
MPC+>1i cm
No CMs on this MPC+ Group
```

## connection

Shows information on the connections running on the MPC+ Group/Connection Manager. The information shown is in two parts: the virtual circuit and the connections under the virtual circuit. The following information is shown for the virtual circuit: the local and remote virtual circuit tokens, the protocol type, and the current state.

### Local Virtual Circuit Token

Token in the device representing this virtual circuit.

### Remote Virtual Circuit Token

Token in the host representing this virtual circuit. This field is blank if not known.

### Protocol

The upper layer protocol that this virtual circuit is using.

### States for the Virtual Circuit

The states for the virtual circuit are:

**Reset** The virtual circuit is currently inactive.

### Active-other side

The other side is currently accepting calls (connections) for this virtual circuit.

### Active-this side

This side is currently accepting calls (connections) for this virtual circuit.

### Active-both sides

Both sides of the virtual circuit are accepting calls (connections) for this virtual circuit.

## Channel Interface Monitoring Commands (Talk 5)

### Not accepting new calls

This connection is not accepting new calls (connections). However, connections that are already running on the virtual circuit will stay up.

The information shown for the connection is the local and remote connection tokens and the current state. For IP protocols (that is, UDP+ and TCP/IP), the local and destination IP addresses associated with the connection will also be shown, if known.

### Local Connection Token

The token in the device representing this connection.

### Remote Connection Token

The token in the host representing this connection. This field is blank if not known.

### States for the Connection

The states for the connection are:

**Reset** The connection is currently inactive

### Pending Active - callee

This side is about to respond to the call request from the other side.

### Pending Active - caller

This side has called out to the other side and is waiting for the other side to response to the call.

### Pending Active - awaiting datastart

The connection is waiting for both sides to be ready to start allowing user data to flow.

**Active** Active and usable

### Local IP address

The IP address on the MPC+ interface in the device that is associated with this connection. This field will be displayed only for IP protocols.

### Destination IP Address

The IP address in the host that is associated with this connection. This field will be displayed only for IP protocols.

### Example: List, active connections for MPC+

```
MPC+>1i conn
MPC+ Connections
Virtual Circuit Token = 090144C22C0000000D
Remote Registration Token(s) = 05000101A5
Protocol = APPN, State = Active-both sides
                Local Connection Token = 090144C3300000000E
                Remote Connection Token = 05000101A6
                State = Active

Protocol = TCP/IP, State = Active-both sides
                Local Connection Token = 090144C4400000000F
                Remote Connection Token = 05000101B0
                State = Active
                Local IP address = 100.0.0.1
                Destination IP address = 100.0.0.2
```

### Example: List, no connections active for MPC+

```
MPC+>1i conn
No User Connections on this MPC+ Group
```

**mpc** Displays information about the MPC+ Group. It displays the local and



## Channel Interface Monitoring Commands (Talk 5)

remote registration token, if known, and the current state of the MPC+ Group. Also, if the MPC+ is for the exclusive use of UDP+, that will be indicated. If the MPC+ Group is not for the exclusive use of UDP+, exclusive use will not be mentioned in the display.

**Note:** UDP+ is not supported on a Parallel Channel Adapter (PCA).

### Example:

```
MPC+>1i mpc
MPC+ Group
Tuning Information: ACKLEN= 10, BLKTIMER= 5
Local registration token = 0901422A3C00000000
Remote registration token = 050001019D
state = Active
This MPC+ Group is for the exclusive use of UDP+.
Outbound protocol data blocking is enabled for the MPC+ Group.
```

### Acklen

The size (in bytes) of acknowledgment frames over this network interface.

### Blktimer

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

### Local registration token

Token in the device representing this MPC+ Group.

### Remote registration token

Token in the host representing this MPC+ Group. This field is blank if not known.

**State** The state of the MPC+ Group:

**Reset** The MPC+ Group is currently inactive.

### Pending Active-xid2(00)

In the process of becoming active and currently processing xid2(00)s.

### Pending Active-xid2(07)

In the process of becoming active and currently processing xid2(07)s.

**Active** Active and usable.

### Pending Reset

Pending inactive (in other words, in the process of coming down).

### subchannel

Shows information about the subchannels that are part of the MPC+ Group. It shows the local subchannel number, logical partition number, Link address, Control Unit (CU) logical address, Device Address, type of Subchannel (READ or WRITE), and the current state of the subchannel. The type should be the opposite of what is configured at the host.

**Example:** List subchannels for MPC+

```
MPC+>1i sub
MPC+ Subchannels
Local  Link  CU Log.  Device
number LPAR  addr    address  address  type    state
-----
      1   0   F4      0       9       READ   Active
      0   0   F4      0       8       WRITE  Active
```

## Channel Interface Monitoring Commands (Talk 5)

**Note:** Only device address is displayed when listing a PCA subchannel.

### Local number

The subchannel address index used internally by the device.

**Note:** CU Logical Address, Link Address, and LPAR are only displayed for ESCON adapters.

**LPAR** Logical partition number. This allows multiple partitions in a logically partitioned (LPAR) host to share one ESCON fiber.

This value is defined in the host Input/Output Configuration Program (IOCP) by the RESOURCE macro instruction.

If the host is not using EMIF, the LPAR number is 0 (zero).

### Link Address

If one ESCON Director (ESCD) is in the communication path, the link address is the ESCD port number that is attached to the host.

If two ESCDs are in the path, the link address is the host-side port number of the ESCD defined with the dynamic connection.

When no ESCD is in the communication path, this value must be set to 0x01.

### CU Logical Address

The Control Unit address defined in the host for the device. This value is defined in the host Input/Output Configuration Program (IOCP) by the CUADD statement on the CNTLUNIT macro instruction.

The Control Unit Address must be unique for each logical partition defined on the same host.

### Device Address

The unit address transmitted on the channel path to select a device. It is also referred to as subchannel number in S/370 I/O architecture. It is a two-digit hexadecimal value that may range from X'00' to X'FF'. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device. It is a two-digit hexadecimal value that may range from X'00' to X'FF'. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device.

**Type** Whether this is a read or write subchannel.

**state** The state of the subchannel:

**Reset** The subchannel is currently inactive.

#### **Pending Active-xid2(00)**

The subchannel is becoming active and currently processing xid2(00)s.

#### **Pending Active-xid2(07)**

The subchannel becoming active and currently processing xid2(07)s.

**Active** The subchannel is active and part of an MPC+ Group.

## Channel Interface Monitoring Commands (Talk 5)

### Pending Reset

The subchannel is pending inactive (in other words, in the process of coming down).

## Tune

Use the **tune** command to modify various MPC+ network handler parameters.

### Syntax:

```
tune                acklen  
                    blktimer
```

### **acklen**

The size (in bytes) of acknowledgment frames over this MPC+ network interface.

**Valid Values:** 0 to 500

**Default Values:** Will prompt for the input value

**Note:** The base network handler with which the MPC+ network handler is associated must be up in order to modify this field.

### **blktimer**

The maximum time (in milliseconds) to wait before sending an unfull data block to the host.

**Valid Values:** 0 to 20

**Default Values:** Will prompt for the input value

**Note:** The base network handler with which the MPC+ network handler is associated must be up in order to modify this field.

## Channel Interface Monitoring Commands (Talk 5)

---

## Chapter 30. ESCON Channel Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

---

### CONFIG (Talk 6) Delete Interface

ESCON channel supports the CONFIG (Talk 6) **delete interface** command with the following considerations:

- All virtual interfaces (LSA, LCS, MPC) on this ESCON interface will also be deleted.
- If this is the last channel (ESCON or PCA) interface on the box, then the APPN loopback interface will also be deleted if it exists.

---

### GWCON (Talk 5) Activate Interface

ESCON channel supports the GWCON (Talk 5) **activate interface** command with the following consideration:

The MAXDATA size will not be set higher than the buffer size allocated for the router at reboot.

All ESCON channel interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

---

### GWCON (Talk 5) Reset Interface

ESCON channel supports the GWCON (Talk 5) **reset interface** command with the following considerations:

- All virtual interfaces (LSA, LCS, MPC) on this ESCON interface will also be reset.
- All virtual interfaces (LSA, LCS, MPC) must allow the reset of their interface. Reasons that a virtual net would not allow the reset of its base net are: For MPC, if the new configuration has more subchannels than the configuration that is currently active, and MPC is unable to get additional storage to support these new subchannels, the reset will not occur. If additional storage is needed, a message will be displayed on the console.
- The MAXDATA size will not be set higher than the buffer size allocated for the router at reboot.

All ESCON channel interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.

---

### GWCON (Talk 5) Temporary Change Commands

ESCON channel supports the following GWCON commands that temporarily change the operational state of the device. These changes are lost whenever the device is reloaded, restarted, or you execute any dynamically reconfigurable command.

<b>Commands</b>
-----------------

GWCON, net, tune iplow

**Note:** Allows the low water mark for the pool of private buffers used for fast-path input to be modified.

GWCON, net, tune opfair

**Note:** Allows the “fair” number of packets that can be queued by this interface to be modified.

GWCON, net, trace

**Note:** Allows the trace mode for the ESCON adapter microcode to be turned on and off.

---

## Chapter 31. PCA Channel Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

---

### CONFIG (Talk 6) Delete Interface

PCA Channel supports the CONFIG (Talk 6) **delete interface** command with the following considerations:

- All virtual interfaces (LSA, LCS, MPC) on this PCA interface will also be deleted.
- If this is the last channel (ESCON or PCA) interface on the box, then the APPN loopback interface will also be deleted if it exists.

---

### GWCON (Talk 5) Activate Interface

PCA Channel supports the GWCON (Talk 5) **activate interface** command with the following consideration:

The MAXDATA size will not be set higher than the buffer size allocated for the router at reboot.

All PCA Channel interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

---

### GWCON (Talk 5) Reset Interface

PCA Channel supports the GWCON (Talk 5) **reset interface** command with the following considerations:

- All virtual interfaces (LSA, LCS, MPC) on this PCA interface will also be reset.
- All virtual interfaces (LSA, LCS, MPC) must allow their interface to be reset. One reason that a virtual net would not allow the reset of its base net is this:  
For MPC, if the new configuration has more subchannels than the configuration that is currently active, and MPC is unable to get additional storage to support these new subchannels, the reset will not occur. If additional storage is needed, a message will be displayed on the console.
- The MAXDATA size will not be set higher than the buffer size allocated for the router at reboot.

All PCA Channel interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.

---

### GWCON (Talk 5) Temporary Change Commands

PCA Channel supports the following GWCON commands that temporarily change the operational state of the device. These changes are lost whenever the device is reloaded, restarted, or you execute any dynamically reconfigurable command.

Commands
----------

GWCON, net, tune iplow
------------------------

<b>Note:</b> Allows the low water mark for the pool of private buffers used for fast-path input to be modified.
---

GWCON, net, tune opfair

**Note:** Allows the “fair” number of packets that can be queued by this interface to be modified.

GWCON, net, trace

**Note:** Allows the trace mode for the PCA adapter microcode to be turned on and off.

GWCON, net, hidtrace

**Note:** Allows the HID tracing for the PCA adapter to be toggled on or off.



---

## Chapter 32. LSA Virtual Channel Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

---

### CONFIG (Talk 6) Delete Interface

LSA Virtual Channel supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

---

### GWCON (Talk 5) Activate Interface

LSA Virtual Channel supports the GWCON (Talk 5) **activate interface** command with the following considerations:

- The base channel (ESCON or PCA) interface for this LSA virtual interface must be active.
- The MAXDATA for this LSA virtual interface cannot be higher than the highest MAXDATA of the virtual interfaces already on the base channel (ESCON or PCA) interface that this LSA virtual interface is on.
- The subchannels for this LSA interface cannot already be in use by another non-LSA virtual interface (MPC or LCS) on the base channel (ESCON or PCA) interface that this LSA virtual interface is on.
- The addition of any new subchannels to the base channel (ESCON or PCA) interface will not put the base channel interface over its maximum number of subchannels.
- There is sufficient storage to add another virtual interface to the base channel (ESCON or PCA) interface. If additional storage is needed, a message will be displayed on the console.

All LSA Virtual Channel interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

---

### GWCON (Talk 5) Reset Interface

LSA Virtual Channel supports the GWCON (Talk 5) **reset interface** command with the following considerations:

- The LSA virtual interface reset will not be allowed if the changes require adapter modifications. Adapter modifications are required if:
  1. The LAN type or LAN number has been changed.
  2. The BLKLEN or ACKLEN has been changed.
  3. The subchannels have been changed, a new subchannel has been added, or an existing subchannel has been deleted from this LSA interface. In order to change any of the above the entire base channel (ESCON or PCA) interface must be reset.
- The LSA virtual interface must already be activated.
- The MAXDATA for the LSA virtual interface is not greater than the highest MAXDATA of the base channel (ESCON or PCA) interface.

All LSA Virtual Channel interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.

---

## GWCON (Talk 5) Temporary Change Commands

LSA Virtual Channel supports the following GWCON commands that temporarily change the operational state of the device. These changes are lost whenever the device is reloaded, restarted, or you execute any dynamically reconfigurable command.

Commands
GWCON, net, tune acklen <b>Note:</b> Changes the operational value of the ACKLEN (acknowledgement length)
GWCON, net, tune blktimer <b>Note:</b> Changes the operational value of the BLKTIMER (block timer)

---

## Chapter 33. LCS Virtual Channel Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

---

### CONFIG (Talk 6) Delete Interface

LCS Virtual Channel supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

---

### GWCON (Talk 5) Activate Interface

LCS Virtual Channel supports the GWCON (Talk 5) **activate interface** command with the following considerations:

- The base channel (ESCON or PCA) interface for this LCS virtual interface must be active.
- The MAXDATA for this LCS virtual interface cannot be higher than the highest MAXDATA of the virtual interfaces already on the base channel (ESCON or PCA) interface that this LCS virtual interface is on.
- The subchannels for this LCS virtual interface cannot already be in use by another non-LCS virtual interface (MPC or LSA) on the base channel (ESCON or PCA) interface that this LCS virtual interface is on.
- The addition of any new subchannels to the base channel (ESCON or PCA) interface will not put the base channel interface over its maximum number of subchannels.
- There is sufficient storage to add another virtual interface to the base channel (ESCON or PCA) interface. If additional storage is needed, a message will be displayed on the console.

All LCS Virtual Channel interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

---

### GWCON (Talk 5) Reset Interface

LCS Virtual Channel supports the GWCON (Talk 5) **reset interface** command with the following considerations:

- The LCS virtual interface reset will not be allowed if the changes require adapter modifications. Adapter modifications are required if:
  1. The LAN type or LAN number has been changed
  2. The BLKLEN or ACKLEN has been changed
  3. The subchannels have been changed for this LCS interface. In order to change any of the above the entire base channel (ESCON or PCA) interface must be reset.
- The LCS virtual interface must already be activated.
- The MAXDATA for the LCS virtual interface is not greater than the highest MAXDATA of the base channel (ESCON or PCA) interface.

All LCS Virtual Channel interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.

---

## GWCON (Talk 5) Temporary Change Commands

LCS Virtual Channel supports the following GWCON commands that temporarily change the operational state of the device. These changes are lost whenever the device is reloaded, restarted, or you execute any dynamically reconfigurable command.

Commands
GWCON, net, tune acklen <b>Note:</b> Changes the operational value of the ACKLEN (acknowledgement length)
GWCON, net, tune blktimer <b>Note:</b> Changes the operational value of the BLKTIMER (block timer)

---

## Chapter 34. MPC Virtual Channel Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

---

### CONFIG (Talk 6) Delete Interface

MPC Virtual Channel supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

---

### GWCON (Talk 5) Activate Interface

MPC Virtual Channel supports the GWCON (Talk 5) **activate interface** command with the following considerations:

- The base channel (ESCON or PCA) interface for this MPC virtual interface must be active.
- The MAXDATA for this MPC virtual interface cannot be higher than the highest MAXDATA of the virtual interfaces already on the base channel (ESCON or PCA) interface that this MPC virtual interface is on.
- The subchannels for this MPC virtual interface cannot already be in use by another virtual interface (MPC, LCS, or LSA) on the base channel (ESCON or PCA) interface that this MPC virtual interface is on.
- The addition of any new subchannels to the base channel (ESCON or PCA) interface will not put the base channel interface over its maximum number of subchannels.
- There is sufficient storage to add another virtual interface to the base channel (ESCON or PCA) interface. If additional storage is needed, a message will be displayed on the console.

All MPC Virtual Channel interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

---

### GWCON (Talk 5) Reset Interface

MPC Virtual Channel supports the GWCON (Talk 5) **reset interface** command with the following considerations:

- The MPC virtual interface reset will not be allowed if the changes require adapter modifications. Adapter modifications are required for the following changes:
  - Changing the LAN type or LAN number.
  - Changing the BLKLEN or ACKLEN.
  - Changing the subchannels, adding a new subchannel, or deleting an existing subchannel from this MPC interface.

For any of these changes, you are required to reset the entire base channel (ESCON or PCA) interface.

- The MPC virtual interface must already be activated.
- The MAXDATA for the MPC virtual interface is not greater than the highest MAXDATA of the base channel (ESCON or PCA) interface.

All MPC Virtual Channel interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.

---

## GWCON (Talk 5) Temporary Change Commands

MPC Virtual Channel supports the following GWCON commands that temporarily change the operational state of the device. These changes are lost whenever the device is reloaded, restarted, or you execute any dynamically reconfigurable command.

Commands
----------

GWCON, net, tune acklen
-------------------------

<b>Note:</b> Changes the operational value of the ACKLEN (acknowledgement length)
---

GWCON, net, tune blktimer
---------------------------

<b>Note:</b> Changes the operational value of the BLKTIMER (block timer)
--

---

## Chapter 35. APPN Loopback Interface Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

---

### CONFIG (Talk 6) Delete Interface

APPN Loopback Interface supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

---

### GWCON (Talk 5) Activate Interface

APPN Loopback Interface supports the GWCON (Talk 5) **activate interface** command with no restrictions.

All APPN Loopback Interface interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

---

### GWCON (Talk 5) Reset Interface

APPN Loopback Interface supports the GWCON (Talk 5) **reset interface** command with no restrictions.

All APPN Loopback Interface interface-specific commands are supported by the GWCON (Talk 5) **reset interface** command.





---

## Chapter 36. Configuring Serial Line Interfaces

This chapter describes the interface configuration process for a serial interface and includes the following sections:

- “Accessing the Interface Configuration Process”
- “Network Interfaces and the GWCON Interface Command” on page 428

**IMPORTANT:** To configure Frame Relay, PPP, X.25, V.25 bis, SDLC Relay, and SDLC protocols on the serial interface, use the commands in this chapter and then refer to the commands in the chapters that describe the specific protocol.

See “Configuring the Network Interface” on page 18 for a table of protocols and the interfaces that support those protocols.

---

### Accessing the Interface Configuration Process

See “Adding Devices” on page 15 for a description of how to add a serial interface. Once you have done that, the following paragraphs describe how to set the data-link of the interface correctly and how to access that data-link’s configuration commands.

To access the interface configuration process for a serial interface, first access the `Config>` prompt and issue the command **set data-link**. Next, at the `Config>` prompt, enter the interface type and number to access the configuration environment for the interface.

For example, to configure a serial interface for X.25, you must access the X.25 `config>` environment by issuing the following commands:

```
Config> set data-link X25 2
Config> network 2
```

From the X.25 `config>` environment, you can complete your configuration of X.25 on the serial interface. See “Chapter 37. Using the X.25 Network Interface” on page 429.

When you are done configuring the serial interface, enter the **restart** command after the `OPCON` prompt (\*) and respond **yes** to the prompt to enable the new configuration.

### Clocking and Cable Type

This section applies to all uses of a serial port for: FR, PPP, X.25, SDLC Relay, and SDLC.

If a modem or CSU/DSU is attached to the serial port then the router is taking on the DTE role in terms of clocking on the line, so configure a DTE cable type and external clocking.

If you want to attach two routers directly without a modem, CSU/DSU, or modem eliminator, then one of the routers will take on the DCE role in terms of clocking on the line. Connect a direct attach cable to the router that will act as the DCE and configure the following parameters for its serial interface.

1. A DCE cable type
2. Internal clocking

## Configuring Serial Line Interfaces

3. The clocking/line speed

The other router will take on the DTE role in terms of clocking and should be configured as if it were attached to a modem or CSU/DSU

**Note:** Configuring a DTE as opposed to a DCE cable has no impact on whether or not the WAN net handler takes on the peer device. For example, the router always acts as a Frame Relay DTE device and uses a FR UNI interface even when a Frame Relay interface is configured to use a DCE cable.

---

## Network Interfaces and the GWCON Interface Command

While serial line interfaces do not have their own console process for monitoring purposes, routers can display complete statistics for all installed network interfaces when you use the **interface** command from the GWCON environment. For more information on the **interface** command and displaying statistics, see Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands.

---

## Chapter 37. Using the X.25 Network Interface

The X.25 network interface connects a router to an X.25 virtual circuit switched network. The X.25 network interface software and hardware allows the router to communicate over a public X.25 network. The X.25 network interface complies with CCITT 1980, CCITT 1984, CCITT 1988 and ISO 8208 1990 specifications for X.25 interfaces offering multiplexed channels and reliable end-to-end data transfer across a wide area network.

This chapter includes the following sections:

- “Basic Configuration Procedures”
- “Null Encapsulation” on page 432
- “Understanding Closed User Groups” on page 433

For information on configuring X.25 Transport Protocol (XTP) for transporting X.25 traffic over TCP/IP, see “Chapter 39. Using XTP” on page 473.

---

### Basic Configuration Procedures

This section outlines the minimal configuration steps required to get the X.25 interface up and running. The X.25 parameters must be consistent with the X.25 network the interface on the router will connect to. For more information, refer to the configuration commands described in this chapter.

**Note:** You must restart the router for the configuration changes to take effect.

1. At the OPCON prompt (\*), type **talk 6**.  
The Config> prompt appears.
2. Type **list devices** to display a list of the interfaces from which you can select. Use the appropriate interface number in the following step.
3. Type **set data-link x25**.  
The Interface Number [0]? prompt appears.
4. Type the appropriate interface number.
5. Connect to the network by typing **net #** at the Config> prompt.  
The X.25 Config [#]> prompt appears.
6. At this prompt, type **set address x.25-node-address**.  
The X.25 address is a unique X.121 address that is used during call establishment. For DDN networks, use the **add htf-addr** and the **set htf-addr** commands to convert the protocol address associated with this interface to the X.121 address format required for DDN address translation. Failure to set the network address prevents the X.25 interface from joining the attached network.
7. Type **set equipment-type** and specify whether the frame and packet levels act as DCE or DTE. The default for this command is DTE.
8. Type **set svc** and define the lowest and highest SVCs that you are using. The default is for 1 SVC.
9. Type **add protocol protocol\_name** to add the protocols that will be running over the X.25 interface. You will be prompted for window size, default packet size, maximum packet size, circuit idle time, and max VCs.

**Note:** You need to add the protocols only once for all X.25 networks on the router.

## Using the X.25 Network Interface

10. Type **add address** *protocol\_name* to add an address translation for each protocol's destination address reachable over this interface.
11. Type **exit** to return to the Config> prompt.
12. Press **Ctrl-P** to return to the OPCON prompt (\*).
13. Type **restart** and respond **yes** to the prompt.

## Setting the National Personality

Each public data network, such as GTE's Telenet or DDN's Defense Data Network, has its own standard configuration. The term *National Personality* specifies a group of variables used to define a public data network's characteristics. The configuration information in the National Personality provides the router with control information for packets being transferred over the link. The National Personality option defines 27 default parameters for each public data network.

To view the configuration values that are in your X.25 National Personality, execute the X.25 configuration **list detailed** command. Configure each public data network connected to the router by executing the X.25 configuration **national-personality set** command.

The National Personality is a generalized template for network configuration. If necessary, you can individually configure each frame and packet layer parameter.

## Understanding the X.25 Defaults

The following tables list the defaults for the various parameters for the X.25 *set*, *national set* and *national enable* commands.

Table 57. Set Command

Parameter	Default
<u>address</u> ...	none
<u>cable</u>	none
<u>calls-out</u> ...	4
<u>clocking</u> ...	external
<u>default-window-size</u> ...	2
<u>encoding</u>	NRZ
<u>equipment-type</u> ...	DTE
<u>htf addr</u> ...	none
<u>inter-frame-delay</u> ...	0
<u>mtu</u>	1500
<u>national-personality</u> ...	GTE Telenet
<u>pvc</u> ...	low=0 high=0
<u>speed</u>	9600
<u>svc</u>	low inbound=0, high inbound=0 low 2-way=1, high 2-way=64 low outbound=0, high outbound=0
<u>throughput-class</u> ...	inbound=outbound=2400
<u>vc-idle</u> ...	30

Table 58. National Enable Parameters

Parameter	DDN Default	GTE Default
accept-reverse-charges	off	on
bi-cug	off	off
bi-cug-with-outgoing-access	off	off
cug	off	off
cug-deletion	off	off
cug-insertion	off	off
cug-with-incoming-access	off	off
cug-with-outgoing-access	off	off
cug-zero-override	off	off
flow-control-negotiation	on	on
frame-ext-seq-mode	off	off
packet-ext-seq-mode	off	off
request-reverse-charges	off	on
suppress-calling-addresses	off	off
throughput-class-negotiation	on	on
truncate-called-addresses	off	off

Table 59. National Set Parameters

Parameter	DDN Default	GTE Default
call-req	20 decaseconds	20 decaseconds
clear-req ...	retries=1	retries=1
	18 decaseconds	18 decaseconds
disconnect-procedure ...	passive	passive
dly-recall-timer...	0	0
dp-timer	500 milliseconds	500 milliseconds
frame-window-size	7	7
n2-timeouts	20	20
packet-size ...	128, max=256	128, max=256
reset ...	retries=1	retries=1
	18 decaseconds	18 decaseconds
restart ...	retries=1	retries=1
	18 decaseconds	18 decaseconds
max-recall-retries ...	3	3
min-recall	10 seconds	10 seconds
min-connect	90 seconds	90 seconds
collision-timer	10 seconds	10 seconds
standard-version	1984	1984
t1-timer	4 seconds	4 seconds
t2-timer	0	0
truncate-called-addr-size	2	2

### Null Encapsulation

Null Encapsulation allows the user to multiplex multiple network layer protocols over one X.25 circuit. This function may be used to avoid using an unreasonable number of virtual circuits.

### Limitations

Null Encapsulation is not supported for QLLC. This function is supported for Switched Virtual Circuits (SVCs), but not for Permanent Virtual Circuits (PVCs).

### Configuration Changes

The encapsulation option NULL has been added for the following T6 commands:

Under X25 config: add address IP (may input enc type = NULL)

Under X25 config: add address IPX (may input enc type = NULL)

Under X25 config: add address DNA (may input enc type = NULL)

Under X25 config: add address VINES (may input enc type = NULL)

Under X25 config: list addr will show active enc type = NULL if the priority 1 type is NULL.

T5 commands:

Under X25 int: List SVCS will include enc type = NULL

### Configuring Null Encapsulation and Closed User Groups (CUG)

Since More than one Protocol can run over one virtual circuit while using Null Encapsulation, the CUG(s) defined for each protocol over that circuit must be the same. It is strongly suggested that the user configure multiple Protocols same destination as follows:

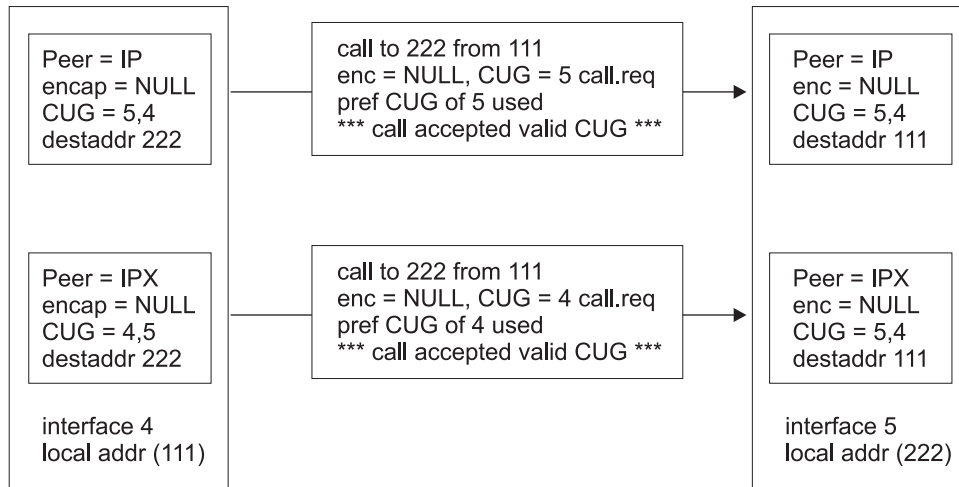
Configure CUG using the add address. The CUG(s) defined must be the same for each protocol defined at the same address.

If the CUG is defined at the add protocol level, The CUG(s) must be the same for all peers. (This method is more restrictive).

Configure CUG at the interface level. This insures all peers have the same CUG values. (This method is the most restrictive)

Any of the above methods may be used as long as any incoming call CUG definition must be valid for all protocols sharing that circuit. Valid means that the CUG was defined for the specific address or was defaulted to use either the protocol or interface circuit definition.

CASE 1: Incoming Closed User Groups (CUG)  
valid for both peers.



CASE 2: Incoming Closed User Groups (CUG)  
not valid for both peers.

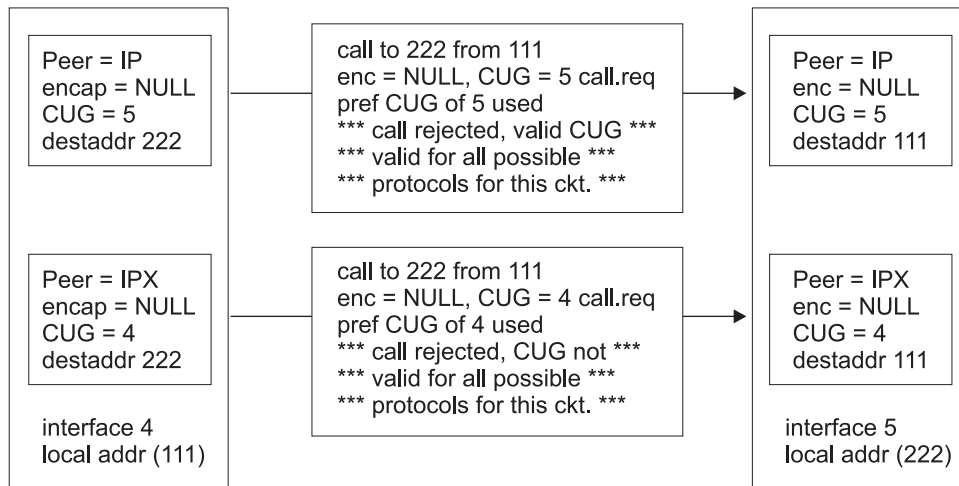


Figure 35. Closed User Group Null Encapsulation

## Understanding Closed User Groups

A *closed user group (CUG)* is a group of X.25 DTEs allowed to establish connections with other specific DTEs. CUG numbers are defined by your network provider and you can only use the CUGs the provider assigns you. You can configure an address-specific CUG, a protocol-specific CUG, or an interface-specific CUG. If all of three types of CUG numbers are configured for a DTE, the closed user group facility uses the address-specific destination CUG in a call request when contacting another DTE. If only a protocol-specific and an interface-specific CUG are configured for a DTE, the closed user group facility uses the protocol-specific CUG in a call request when contacting another DTE.

## Using the X.25 Network Interface

A single DTE can belong to multiple CUGs. You must specify a preferred CUG for that DTE. The preferred CUG is used when the router initiates calls to other DTEs. A single DTE cannot have more than a total of 5 preferred or normal closed user groups.

## Bilateral Closed User Groups

A *bilateral closed user group (BCUG)* is a closed user group consisting of only two DTEs. The DTEs within the BCUG can originate calls to members of the BCUG and any DTEs that are not members of any CUG or BCUG. A single DTE cannot have more than a total of 5 preferred or normal bilateral CUGs.

A DTE uses a BCUG to establish circuits in the same way the DTE uses CUGs to establish circuits (see Table 60), however, if both a BCUG and a CUG is defined for an interface, protocol, or address, the BCUG is used to establish the circuit.

## Types of Extended Closed User Groups

The following extensions to closed user groups are supported:

### CUG with Outgoing Access

The DTE can belong to one or more CUGs. The DTE can originate calls to members of the CUG and to any DTE belonging to other CUGs with Incoming Access.

### CUG with Incoming Access

The DTE can belong to one or more CUGs. The DTE can receive calls from DTEs not belonging to any CUG or from DTEs belonging to other CUGs with Outgoing Access.

### BCUG with Outgoing Access

The DTE can belong to one or more BCUGs. The DTE can originate calls to members of the BCUG and to any DTE not belonging to any BCUG.

## Establishing X.25 Circuits with Closed User Groups on a Device

When you have enabled the closed user group facility, and a DTE receives a call request, it uses the CUG in the call request to determine whether to accept or reject the call from the DTE. If the CUG in the call request does not match a configured CUG on the interface, protocol, or on the destination associated with the calling DTE, the request is rejected. Table 60 summarizes how X.25 circuits are established based on CUGs, if the interface, protocol, and address CUG numbers are different and incoming access is not enabled.

Table 60. Establishing Incoming X.25 Circuits for Closed User Groups

Incoming Call Request Contains	Receiving DTE CUG Definition							
	Interface CUG Only	Protocol CUG Only	Address Specific CUG	Interface and Protocol CUG	Interface and Address CUG	Protocol and Address CUG	All CUGs	No CUGs
No CUG	Reject	Reject	Reject	Reject	Reject	Reject	Reject	Accept
Interface CUG	Accept	Reject	Reject	Reject	Reject	Reject	Reject	Reject
Protocol CUG	Reject	Accept	Reject	Accept	Reject	Reject	Reject	Reject
Address Specific CUG	Reject	Reject	Accept	Reject	Accept	Accept	Accept	Reject



## Using the X.25 Network Interface

For outgoing calls on an interface, if you have enabled either the CUG or the BCUG facility, each call request will contain the configured preferred CUG (if any) for the destination or, if no address-specific CUG is configured, the CUG used is the CUG defined for the protocol, or if no protocol-specific CUG is configured, the CUG used is the CUG defined for the interface. If no CUG number has been configured, the CUG facility is not included in any outgoing call request.

### Overriding Closed User Group Processing for CUG 0

You can configure the DTE such that it does not validate incoming calls with a CUG of 0 in the call request. This ability allows you to permit specific calls to complete even when you have not enabled incoming access. Using the **national enable cug 0 override** command forces the device to ignore the CUG facility if the CUG number is 0. The call request will not be compared with any configured CUG number.

## Configuring X.25 Closed User Groups

To use closed user groups on X.25 interfaces:

1. Request CUG numbers from your network provider. You will need these numbers when configuring X.25.
2. Enable the closed user group facility using the **national enable cug** command and related commands.
3. Enable the bilateral closed user group facility, if desired, using the **national enable bi-cug** command and related commands.
4. Configure the appropriate CUG numbers for the DTEs. Specify the preferred CUG, CUG, preferred bilateral CUG, and bilateral CUG, as needed. This is done through the **add address** command.
5. Configure the appropriate CUG and bilateral CUG for the protocol, if required. This is done through the **add protocol** command.

**Note:** You should only configure these CUGs if you are restricting all X.25 circuits established over the X.25 interface for this protocol to DTEs belonging to this set of unique CUGs or BCUGs unless you override it with an address-specific CUG.

6. Configure the appropriate CUG and bilateral CUG for the interface, if required. This is done through the **add cug** command.

**Note:** You should only configure these CUGs if you are restricting all X.25 circuits established over the X.25 interface to DTEs belonging to this set of unique CUGs or BCUGs unless you override it with an address or protocol-specific CUG.

## Using the X.25 Network Interface

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## Chapter 38. Configuring and Monitoring the X.25 Network Interface

This chapter describes the X.25 configuration and operational commands and includes the following sections:

- “X.25 Configuration Commands”
- “Accessing the Interface Monitoring Process” on page 463
- “X.25 Monitoring Commands” on page 464
- “X.25 Network Interfaces and the GWCON Interface Command” on page 467
- “X.25 Network Interface Dynamic Reconfiguration Support” on page 470

---

### X.25 Configuration Commands

This section summarizes and explains all the X.25 configuration commands.

The X.25 configuration commands allow you to specify network parameters for router interfaces that transmit X.25 packets. The information you specify with the configuration commands activates when you restart the router.

Enter the X.25 configuration commands at the `X.25 config>` prompt. Table 61 shows the commands.

*Table 61. X.25 Configuration Commands Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Set	Sets the local and DDN X.25 node addresses, window size for packet levels, identifies the National personality, the MTU, and the maximum number of calls. Defines the PVC and SVC channel ranges, the number of seconds that a switched circuit can be idle before it is cleared, and specifies whether one router needs to act as a DCE (when two routers are directly connected without an intervening X.25 network) or the more normal method of acting at a DTE connected to an X.25 network. Sets speed, encoding, clocking, throughput class, and cable type.
Enable/Disable	Enables/Disables incoming-calls-barred feature, outgoing-calls-barred feature, dynamic DDN address translations, and lower-dtr feature.
National Enable or National Disable	Enables/Disables the parameters defined by the National Personality configuration.
National Set	Sets parameters defined by the National Personality configuration.
National Restore	Restores the National Personality configuration to its default values.
Add/Change/Delete	Adds/Changes/Deletes an address translation, a protocol encapsulation, or a PVC definition.
List	Lists the defined address translations, National Personality parameters, protocol encapsulation, or PVC definitions.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Set

Use the **set** command to configure local X.25 node addresses, maximum number of calls, frame and packet level window size, lowest to highest PVC and SVC channels, and the idle time for a switched circuit.

## Configuring the X.25 Network Interface

### Syntax:

**set**                                    address . . .  
    cable  
    calls-out . . .  
    clocking . . .  
    default-window-size . . .  
    encoding  
    equipment-type . . .  
    htf addr . . .  
    inter-frame-delay . . .  
    mtu  
    national-personality . . .  
    pvc . . .  
    speed . . .  
    svc  
    throughput-class . . .  
    vc-idle . . .

### **address** *x.25-node-addr*

Sets the local X.25 interface address (*x.25-node-addr*). Set the X.25 node address to 0, not to 00, to delete the local X.25 address.

**Example:** **set address 8982800**

### **cable** *type*

Sets the cable type as follows:

- RS-232 DTE
- RS-232 DCE
- V35 DTE
- V35 DCE
- V36 DTE
- V36 DCE
- X21 DTE
- X21 DCE

A DTE cable is used when you are attaching the router to some type of DCE device (for example, a modem or a DSU/CSU).

A DCE cable is used when the router is acting as the DCE and providing the clocking for direct attachment.

### **Notes:**

1. If you are configuring an interface on the 8-port EIA 232 adapter then the only cable types you can configure are RS-232 DTE and RS-232 DCE.
2. If you are configuring an interface on the 6-port V.35/V.36 adapter then the only cables types you can configure are V.35 DTE, V.35 DCE, V.36 DTE, V.36 DCE.
3. If you are configuring an interface on the 8-port X.21 adapter then the only cable types you can configure are X.21 DTE and X.21 DCE.

## Configuring the X.25 Network Interface

### **calls-out** *value*

Sets the maximum number of locally initiated, simultaneously active SVCs.

**Valid Values:** 1 to 239

**Default Value:** 4

### **clocking** *external or internal*

To connect to a modem or DSU, configure external clocking and select the appropriate DTE cable with the **set cable** command. Use the **set speed** command to configure the line speed.

To connect directly to another DTE device, configure internal clocking, select the appropriate DCE cable with the **set cable** command, and configure the clocking/line speed with the **set speed** command.

**Default:** external

### **default-window-size** *value*

Sets the window size for the packet level assigned by the router if there is no window-size facility in the Call-Request packet. The range is determined by the National Personality packet modulus (PACKET-EXT-SEQ-MODE).

**Default:** 2

**Example:** **set default-window-size 3**

### **encoding** *NRZ or NRZI*

Sets the HDLC transmission encoding scheme for the interface. Encoding may be set for NRZ (non-return to zero) or NRZI (non-return to zero inverted). NRZ is the more widely used encoding scheme while NRZI is used in some IBM configurations.

**Default:** NRZ

### **equipment-type** *DCE or DTE*

Specifies whether the frame and packet levels act as DCE or DTE. This command has no relation to the cable type in use.

**Default:** DTE (must be DTE for X.31)

### **htf addr** *x.25-node-addr*

Sets the local DTE address when DDN is used. It converts the IP address to an X.121 address as opposed to the **set address** command, which is used to set the local DTE address when CCITT is used.

### **inter-frame-delay** *value*

This parameter defines the minimum delay between transmitted frames. Setting this parameter is useful when interfacing directly to older equipment. This parameter is the amount of time between frames in seconds.

**Note:** If you configure a non-zero inter-frame delay for a X.25 interface on the 8-port EIA-232E adapter, 6-port V.35/V.36 adapter, or 8-port X.21 adapter, you configure the speed using the **set speed** command.

**Default:** 0

### **mtu** *value*

Sets the Maximum Transmit Unit (MTU) in bytes. This is the maximum message size that will be delivered to the X.25 interface to package and transmit over the serial line. The range is 576 to 16384.

**Default:** 1500

## Configuring the X.25 Network Interface

If you are encountering packet reassembly timeouts when transferring data over the X.25 interface, you should determine what the minimum packet size is for all LAN or serial interfaces that lead to the end-point, then calculate a more suitable X.25 MTU. You should not directly consider the actual X.25 packet size in this calculation because X.25 tends to use a smaller packet size. X.25 usually sends up to 7 packets at one time before waiting for an acknowledgment.

For example, consider a network topology that includes:

- A Token-Ring LAN having a packet size of 4000
- An X.25 serial line having a packet size of 128 with a window size of 7 and a bit rate of 9600 bps
- An Ethernet LAN with a packet size of 1500

In this case, you should probably set the X.25 MTU to 1500. That means that about 12 packets will be sent over the X.25 interface. ( $MTU / X.25 \text{ packet size} = \text{number of X.25 packets to be sent}$ ).

When using an MTU of 4096, 32 packets must be sent over the X.25 interface. ( $4000 / 128 = 31.25$ ). In this case, packet reassembly timeouts will probably occur if the X.25 modem speed is 9600 bps. Using an X.25 modem speed of 56 kbps would probably solve this problem.

### Notes:

1. The MTU parameter has significant impact on the memory requirements and memory utilization of the device. Use an MTU value of 8192 or less for devices with less than 8M of memory.
2. The amount of memory available while the device is running limits the number of SVCs that can be established and still maintain optimal performance. For recommendations on the maximum number of SVCs see the product home page on the World Wide Web.

### **national-personality** *GTE-Telenet or DDN*

Sets the 28 default parameters for either GTE-Telenet or DDN National Personality.

**Default:** GTE-Telenet

### **pvc low/high** *value*

Defines the lowest to the highest Permanent Virtual Circuit channel number. Zero indicates no PVCs. By default there are no PVCs.

#### **pvc low**

0

#### **pvc high**

0

The range is 1 to 4095. These values are setting boundaries of a given VC range. There is a maximum of 2500 PVCs.

**Example:** `set pvc low 40`

**Note:** Values must not overlap values set for SVCs.

### **speed** *speed-setting*

For internal clocking, use this command to specify the speed of the transmit and receive clock lines.

## Configuring the X.25 Network Interface

For external clocking, this command does not affect the operation of the WAN/serial line but it does set the speed that some protocols, such as IPX, use to determine routing cost parameters. You should set the speed to match the actual line speed.

### Valid Values:

Internal Clocking: See Table 62

External Clocking: See Table 63

**Note:** The X.25 software is supported only at speeds up to 256 000 bps.

Table 62. Line Speeds When Internal Clocking is Used for 2216 Interfaces

Adapter Type	Speed Range
8-port EIA 232	9600 to 64 000 bps
6-port V.35/V.36	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps
8-port X.21	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps

Table 63. Line Speeds When External Clocking is Used for 2216 Interfaces

Adapter Type	Speed Range
8-port EIA 232	2400 to 64 000 bps
6-port V.35/V.36	2400 to 2 048 000 bps
8-port X.21	2400 to 2 048 000 bps

**Default:** 9600

### **svc low/high** *inbound or two-way or outbound value*

Defines the lowest to the highest switched virtual circuit channel number. When low=high=0, no VCs in this category are defined.

**Example:** set SVC low-two-way 1

#### **Inbound**

Specifies the range of logical channel numbers to be assigned to inbound SVCs. By default, there are no inbound-only SVCs.

**Valid values:** 0 to 4095

**Default values:** 0

#### **Two-way**

Specifies the range of logical channel numbers to be assigned to two-way SVCs. By default, there are sixty-four 2-way SVCs.

**Valid values:** 0 to 4095

**Default values:**

**svc low**

1

**svc high**

64

#### **Outbound**

Specifies the range of logical channel numbers to be assigned to outbound SVCs. By default, there are no outbound-only SVCs.

**Valid values:** 0-4095

**Default:** 0

## Configuring the X.25 Network Interface

**Note:** Values in each range must not overlap other SVC ranges nor the PVC range. Table 64 shows a possible VC configuration.

Table 64. Example VC Definitions

	Low	High
PVC	1	40
inbound	0	0
two-way	41	59
outbound	60	500

### throughput-class inbound or outbound *bit-rate*

Defines the throughput class requested when making a call request while throughput negotiation is enabled.

**Default:** 2400 bps

This setting is ignored when processing incoming call requests.

### vc-idle *value*

Defines the number of seconds that a switched circuit can be idle before it is cleared by the router. Zero indicates that the router never clears an idle circuit.

**Valid values:** 1 to 255

**Default:** 30 seconds

## Enable

Use the **enable** command to enable DDN address translations, interface resets, or the incoming-calls-barred, outgoing-calls-barred, and lower-dtr features.

### Syntax:

**enable** ddn—address-translations

**Note:** Enabling `ddn-address-translations` is no longer allowed. This feature defaults to enabled when the national personality selected is DDN, and defaults to disabled in all other cases.

incoming-calls-barred

lower-dtr

outgoing-calls-barred

### incoming-calls-barred

Specifies that the router will not accept incoming calls. The default setting for this parameter is disabled or *off*, which allows incoming calls.

### lower-dtr

This parameter determines the way the data terminal ready (DTR) signal is handled for leased serial-line interfaces that are disabled. If this parameter is set to "disabled" (the default), the DTR signal will be raised when the interface is disabled.

If *lower-dtr* is set to "enabled," the DTR will be lowered when the interface is disabled. This behavior may be desirable in situations where the interface



## Configuring the X.25 Network Interface

has been configured as an alternate link for WAN Reroute and the interface is connected to a dial-out modem which maintains its dial connection based on the state of the DTR signal.

When lower-dtr is enabled and the interface is disabled, the DTR signal is low and the modem keeps the dial connection down. When the interface is enabled, due to a WAN Reroute backup scenario, DTR is raised and the modem dials a stored number to the backup site. When the primary interface is restored, the alternate interface is disabled, DTR is lowered, and the modem hangs up the dial connection.

The following cable types are supported:

- RS-232
- V.35
- V.36

The default setting is disabled.

### **outgoing-calls-barred**

Specifies that the router will not allow outgoing calls. The default setting for this parameter is disabled or *off*, which allows outgoing calls.

## Disable

Use the **disable** command to disable DDN address translations, interface resets as part of network certification, or the incoming-calls-barred or outgoing-calls-barred features.

**Note:** If you set DDN as the national personality, DDN address translation is enabled automatically and this parameter has no effect.

### **Syntax:**

**disable** ddn-address-translations

**Note:** Disabling ddn-address-translations is no longer allowed. This feature defaults to enabled when the national personality selected is DDN, and defaults to disabled in all other cases.

incoming-calls-barred

lower-dtr

outgoing-calls-barred

## National Enable

Use the **national enable** command to enable a feature defined in the National Personality configuration.

### **Syntax:**

**national enable** accept-reverse-charges

bi-cug

bi-cug-outgoing-access

cug

cug-deletion

## Configuring the X.25 Network Interface

cug-incoming-access

cug-insertion

cug-outgoing-access

cug-zero-override

flow-control-negotiation

frame-ext-seq-mode (required for X.31)

packet-ext-seq-mode

request-reverse-charges

suppress-calling-addresses

throughput-class-negotiation

truncate-called-addresses

### **accept-reverse-charges**

Accepts reverse charge calls during call establishment. This option is not available for DDN.

#### **DDN Default**

off

#### **GTE Default**

on

**bi-cug** Enables the bilateral closed user group facility on this device. By default, this facility is disabled.

**Note:** You cannot add any bilateral CUGs unless this parameter is enabled.

### **bi-cug-outgoing-access**

Enables the bilateral CUG with outgoing access facility on this device. By default, this facility is disabled.

**cug** Enables the closed user group facility on this device. By default, this facility is disabled.

**Note:** You cannot add any CUGs unless this parameter is enabled.

### **cug-deletion**

Deletes a CUG facility from a call packet received from XTP before transmitting it over X.25. By default, this function is disabled.

### **cug-incoming-access**

Enables the CUG with incoming access facility on this device. By default, this facility is disabled.

### **cug-insertion**

Inserts the appropriate (address-specific, protocol-specific, or interface-specific) preferred cug number into a call request received by XTP from the X.25 interface before transmitting the request over IP. If there is already a CUG facility in the call packet, it will not be replaced. By default, this function is disabled.

### **cug-outgoing-access**

Enables the CUG with outgoing access facility on this device. By default, this facility is disabled.

## Configuring the X.25 Network Interface

### **cug-zero-override**

Causes the closed user group facility to ignore any CUG facility in call request packets with a CUG number of 0. By default, this function is disabled.

### **flow-control-negotiation**

Enables the negotiation of packet and window size during call setup of SVCs.

#### **DDN Default**

on

#### **GTE Default**

on

### **frame-ext-seq-mode**

Sets the frame layer sequence numbering to modulo 128 (that is, 0 through 127).

#### **DDN Default**

off (must be on for X.31)

#### **GTE Default**

off

### **packet-ext-seq-mode**

Enables the packet layer to use extended sequence numbers (0 through 127).

#### **DDN Default**

off

#### **GTE Default**

off

### **request-reverse-charges**

Requests reverse charges for all outgoing calls.

#### **DDN Default**

off

#### **GTE Default**

on

### **suppress-calling-address**

Suppresses the source address in call packets.

#### **DDN Default**

off

#### **GTE Default**

off

### **throughput-class-negotiation**

Enables the registration of throughput class.

#### **DDN Default**

off

#### **GTE Default**

on

### **truncate-called-addresses**

Enables truncation of the called DTE address when transmitting a call to a DTE. This option applies only to XTP circuits.

## Configuring the X.25 Network Interface

**DDN Default**  
off

**GTE Default**  
off

## National Disable

Use the **national disable** command to disable a feature defined by the National Personality configuration.

### Syntax:

**national disable**                    acept-reverse-charges  
bi-cug  
bi-cug-outgoing-access  
cug  
cug-deletion  
cug-incoming-access  
cug-insertion  
cug-outgoing-access  
cug-zero-override  
flow-control-negotiation  
frame-ext-seq-mode  
packet-ext-seq-mode  
request-reverse-charges  
suppress-calling-addresses  
throughput-class-negotiation  
truncate-called-addresses

## National Set

Use the **national set** command to set one or all of the default values made to the National Personality configuration.

### Syntax:

**national set**                    call-req  
clear-req . . .  
disconnect-procedure . . .  
dly-recall-timer . . .  
dp-timer  
frame-window-size  
n2-timeouts  
packet-size . . .  
reset . . .

## Configuring the X.25 Network Interface

restart . . .  
max-call-retries . . .  
min-recall  
min-connect  
collision-timer  
standard-version  
t1-timer  
t2-timer  
truncate-called-addr-size

### **call-req**

Specifies the number of 10-second intervals permitted before giving up on a call request and clearing it. A zero indicates an infinite wait. In a list command output, this is displayed as the t21 timer.

#### **DDN Default**

20 decaseconds

#### **GTE Default**

20 decaseconds

### **clear-req** *retries or timer*

Specifies the number of clear request retransmissions.

#### **Retries**

Number of clear request transmissions permitted before action is taken. In a list command output, this is displayed as the r23 retry count.

#### **DDN Default**

retries=1

#### **GTE Default**

retries=1

**Timer** Number of 10-second intervals to wait before retransmitting a clear request packet. A zero in the timer value indicates an indefinite wait. In a list command output, this is displayed as the t23 timer.

#### **DDN Default**

18 decaseconds

#### **GTE Default**

18 decaseconds

### **disconnect-procedure** *passive or active*

Specifies the type of connect procedure to use when connecting.

#### **DDN Default**

passive

#### **GTE Default**

passive

#### **Passive**

Specifies that SABM frames are not initiated by the router when connecting.

## Configuring the X.25 Network Interface

**Active** Specifies that SABM frames are initiated by the router when connecting.

### dly-recall-timer

**This command does not apply to XTP or QLLC.** Specifies the time to delay after consecutive failing max-call-retries have been attempted. Min-recall timer will continue to be used to delay between call attempts until max-call-retries are exceeded. No call attempts will be attempted while the min-recall or dly-recall timer is running. The range is 0 to 1080 minutes. Specify 0 when the dly timer is not used.

#### DDN Default

0

#### GTE Default

0

**Example: national set dly-recall 30**

### dp-timer

Specifies the number of milliseconds that the frame level remains in a disconnected state. Zero indicates immediate transition from disconnected phase to link setup state.

#### DDN Default

500 milliseconds

#### GTE Default

500 milliseconds

### frame-window-size

Specifies the number of frames that can be outstanding before acknowledgment.

#### DDN Default

7

#### GTE Default

7

### n2-timeouts

Specifies the number of times the retransmit timer (T1) can expire before the interface is recycled.

#### DDN Default

20

#### GTE Default

20

### packet-size *default or maximum or window*

Specifies the size of the packet.

#### default

Number of bytes in the data portion of the packet. Possible options include 128, 256, 512, 1024, 2048, and 4096. This value is used in the absence of packet size negotiation. *Default* cannot be greater than *maximum*.

#### DDN Default

128

#### GTE Default

128

## Configuring the X.25 Network Interface

### **maximum**

Maximum number of bytes in the data portion of the packet. Possible options include 128, 256, 512, 1024, 2048, and 4096.

#### **DDN Default**

256

#### **GTE Default**

256

### **window**

Number of outstanding I-frames permitted before acknowledgment is required. The range is determined by the National Personality Packet Modulus.

Related configuration parameters are

- Protocol max default window
- Set default window size

### **reset** *retries or timer*

Specifies the number of reset request retransmissions.

**Example: national set reset retries 2**

#### **retries**

Number of reset request transmissions permitted before the call is cleared. The range is 0 to 255. In a list command output, this is displayed as the r22 retry count.

#### **DDN Default**

1

#### **GTE Default**

1

**timer** Number of 10-second intervals to wait before retransmitting a reset request packet. The range is 0 to 255. A zero in the timer value indicates an indefinite wait. In a list command output, this is displayed as the t22 timer.

#### **DDN Default**

18 decaseconds

#### **GTE Default**

18 decaseconds

### **restart** *retries or timer*

Specifies the number of restart request transmissions.

#### **retries**

Number of restart request transmissions permitted before the interface is recycled. The range is 0 to 255. In a list command output, this is displayed as the r20 retry count.

#### **DDN Default**

1

#### **GTE Default**

1

**timer** Number of 10-second intervals to wait before retransmitting a restart request packet. The range is 0 to 255. A zero in the timer value indicates an indefinite wait. In a list command output, this is displayed as the t20 timer.

## Configuring the X.25 Network Interface

### **DDN Default**

18 decaseconds

### **GTE Default**

18 decaseconds

### **max-recall-retries**

**This command does not apply to XTP or QLLC.** Specifies how many re-call attempts (per destination) will be made before clearing data and starting the delay recall timer. Max-call-retries are defined across an interface. Specify 0 for no recall attempts.

### **DDN Default**

3

### **GTE Default**

3

**Example: national set max-call-retries 5**

### **min-recall**

Specifies the minimum number of seconds to wait prior to reinitiating a call to open an SVC. The range is 0 to 255 seconds.

### **DDN Default**

10 seconds

### **GTE Default**

10 seconds

### **min-connect**

Specifies in seconds, the minimum amount a time an SVC will remain established once the connection is made barring any error conditions. The range is 0 to 255 seconds.

### **DDN Default**

90 seconds

### **GTE Default**

90 seconds

### **collision-timer**

Specifies in seconds, the time delay used prior to reinitiating a call to open an SVC if the original attempt resulted in a call collision. The range is 0 to 255 seconds.

### **DDN Default**

10 seconds

### **GTE Default**

10 seconds

### **standard-version**

Options are none, v1980, v1984, and v1988.

### **DDN Default**

1984

### **GTE Default**

1984

### **t1-timer**

Specifies the frame retransmit time in seconds. The range is 1 to 255.



**DDN Default**  
4 seconds

**GTE Default**  
4 seconds

### **t2-timer**

Specifies the amount of time in seconds to delay before acknowledging an I-frame. This is an optimization parameter. Setting the timer to 0 disables it. The range is 0 to 255.

**DDN Default**  
0

**GTE Default**  
0

### **truncate-called-addr-size**

Specifies the number of characters truncated from the end of a called address. This parameter pertains only to XTP circuits. The range is 0 to 10.

**DDN Default**  
2

**GTE Default**  
2

## National Restore

Use the **national restore** command to restore one or all of the default values made to the National Personality configuration via the **national set**, **national enable**, or **national disable** command.

### **Syntax:**

```
national _restore          all  
                             accept-reverse-charges  
                             bi-cug  
                             bi-cug-outgoing-access  
                             call-req  
                             clear-req . . .  
                             cug  
                             cug-deletion  
                             cug-incoming-access  
                             cug-insertion  
                             cug-outgoing-access  
                             cug-zero-override  
                             disconnect-procedure . . .  
                             dp-timer  
                             flow-control-negotiation  
                             frame-ext-seq-mode  
                             frame-window-size
```

## Configuring the X.25 Network Interface

min-collision-timer  
min-connect-timer  
min-recall-timer  
network-type . . .  
n2-timeouts  
packet-size . . .  
packet-ext-seq-mode  
request-reverse-charges  
reset . . .  
restart . . .  
standard-version  
suppress-calling-addresses  
throughput-class-negotiation  
t1-timer  
t2-timer  
truncate-called-addresses  
truncate-called-addr-size

## Add

Use the **add** command to add an X.121 address, a DDN X.25 Address, a protocol configuration, or a PVC definition.

### Syntax:

add                    address  
                          bi-cugs  
                          cugs  
                          htf-address  
                          protocol  
                          pvc

### address

Adds an X.121 address translation for a protocol supported in the configuration of the router. The prompts that appear depend on the protocol address that you are adding. (See the following examples.) The protocol address and X.121 address being entered represent the protocol and X.121 DTE address of the remote DTE connecting to the router X.25 interface. The mapping of a protocol address and the X.121 address must be unique unless the protocol is APPN or DLSw. A protocol address cannot map to more than one X.121 address. Also, a specific X.121 address cannot map to more than one protocol address. The **set address** command is used to set the local X.25 address. After setting the local X.25 address, you can use an X.25 remote address to dial out and an optional incoming remote address for call ID. If only remote called address is entered, then this address will be used for outgoing calls and incoming call verification.

## Configuring the X.25 Network Interface

### Example: add address

#### IP example:

```
Protocol [IP]? IP
IP Address [0.0.0.0]? 128.185.1.2
Enc Priority 1 []? CC
Enc Priority 2 []? SNAP
Enc Priority 3 []? Nu11
X.25 Address []? 1234590
Remote address []?
Pref CUG []? 11
CUG (2) []? 12
CUG (3) []? 13
CUG (4) []? 14
CUG (5) []? 15
Pref BI-CUG []? 21
BI-CUG (2) []? 22
BI-CUG (3) []?
```

#### IPX example:

```
Protocol [IP]? IPX
CUD Field Usage (Standard or Proprietary)
IPX Host Number (in hex) []?
Enc Priority 1 []? SNAP
Enc Priority 2 []?Nu11
X.25 Address []?
Pref CUG [] ?
Pref Bi-CUG[]? 1
BI-CUG (2) []? 3
BI-CUG (3) []
```

#### Protocol

Specifies the protocol type of the address mapping you are adding. The valid values are APPN, DECnet, DLSw, IP, IPX and VINES. The default is IP.

#### Enc Priority

Determines the encapsulation type, as defined in RFC 1356, that will be put in the CUD. For IP, valid choices are CC, SNAP, or Null. For IPX, valid choice is SNAP or Null.

#### IP Address

Specifies the destination's IP address.

#### CUD Field Usage

This field is for IPX to X.25 address mapping only. It determines how the Call User Data (CUD) field is filled in when call request packets are received for IPX. The CUD field can be either Standard or Proprietary. Standard indicates that the usage is protocol multiplexing used in RFC 1356. Proprietary indicates a proprietary CUD field that can only be used with 2216 or compatible routers. The default is Standard.

#### IPX Host Number

Specifies the IPX host number of the destination.

#### X.25 Address

Specifies the X.121 DTE address of the remote DTE connecting to the router X.25 interface. The maximum address length is 15 digits.

#### pref cug

Specifies the preferred closed user group number for this DTE. The DTE uses this CUG when placing outgoing calls. **Valid values:** 0 to 9999

**Default value:** None

## Configuring the X.25 Network Interface

**Note:** You will not be prompted for this value if you have not enabled the closed user group facility using the **national enable** command.

**CUG** Specifies the closed user group numbers for this DTE. Up to five CUGs may be defined, including the pref CUG. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the closed user group facility using the **national enable** command.

### pref bi-cug

Specifies the bilateral closed user group number for this DTE. The DTE uses this CUG when placing outgoing calls. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the bilateral closed user group facility using the **national enable** command.

**bi-cug** Specifies the bilateral closed user group numbers for this DTE. Up to five CUGs may be defined. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the bilateral closed user group facility using the **national enable** command.

**cugs** Specifies the closed user group number for this X.25 interface. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the closed user group facility using the **national enable** command.

### Example:

```
add cugs
Pref CUG [ ]? 23
CUG (2) [ ]? 24
CUG (3) [ ]? 25
CUG (4) [ ]? 26
CUG (5) [ ]? 27
```

### pref cug

Specifies the preferred closed user group number for this DTE. This DTE uses this CUG when placing outgoing calls. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the closed user group facility using the **national enable** command.

## Configuring the X.25 Network Interface

**cug** Specifies the closed user group numbers for this DTE. Up to five CUGs may be defined. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the closed user group facility using the **national enable** command.

### bi-cugs

Specifies the closed user group number for this DTE. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the closed user group facility using the **national enable** command.

### Example:

```
add bi-cugs
Pref BI-CUG []? 23
BI-CUG (2) []? 24
BI-CUG (3) []? 25
BI-CUG (4) []? 26
BI-CUG (5) []? 27
```

### pref bi-cug

Specifies the preferred closed user group number for this DTE. This DTE uses this BI-CUG when placing outgoing calls. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the bilateral closed user group facility using the **national enable** command.

**bi-cug** Specifies the closed user group numbers for this DTE. Up to five BI-CUGs may be defined. **Valid values:** 0 to 9999

**Default value:** None

**Note:** You will not be prompted for this value if you have not enabled the bilateral closed user group facility using the **national enable** command.

### htf-address

Adds a Defense Data Network (DDN) X.25 address translation.

### Example:

```
add htf-address
Protocol [IP]
Convert HTF address
```

### Protocol

Specifies the protocol that you are running over the X.25 interface. DDN supports IP only.

### Convert HTF address

Converts the protocol address to a destination X.121 address in

## Configuring the X.25 Network Interface

Host Table Format (HTF) format. Also see `ddn-address-translations` in the Enable/Disable commands section.

### protocol

Enables a protocol encapsulation and defines the associated parameters.

#### Example:

```
add protocol
Protocol [IP]?
Window Size [2]?
Default Packet Size [128]?
Maximum Packet Size [256]?
Circuit Idle Time [30]?
Max VCs [4]?
Pref CUG []? 1
CUG (2) []? 2
CUG (3) []? 3
CUG (4) []? 4
CUG (5) []? 5
Pref BI-CUG []? 11
BI-CUG (2) []? 12
BI-CUG (3) []? 13
BI-CUG (4) []? 14
BI-CUG (5) []? 15
```

#### QLLC example:

```
X.25 Config> add prot
Protocol [IP]? dls
Idle timer [30]?
QLLC response timer (in decaseconds) [2]?
QLLC response count [3]?
Accept Reverse Charges [N]?
Request Reverse Charges [N]?
Station Type (1) PRI (2) SEC (3) (PEER) [3]?
Max Packet Size [128]?
Packet window size [7]?
Max Message Size [1500]?
Call User Data (in hex, 0 for null) []?
Pref CUG []? 20
CUG (2) []? 21
CUG (3) []?
Pref BI-CUG []?
```

#### Protocol

Specifies which protocol's encapsulation parameters you want to add: APPN, XTP, IP, DECnet, IPX, DLSw, or Banyan VINES. The default is IP.

#### Window Size

Specifies the maximum negotiable packet window size, the number of packets that can be outstanding before requiring packet confirmation. The default is 2. The window size can be negotiated down to 1 by the called DTE.

Related configuration parameters are:

- Set Default Window

#### Default Packet Size

Specifies the default requested packet size for SVCs. This value serves as the lowest negotiable packet size and must be equal to or less than the maximum packet size specified with the **national set packet-size** command. The maximum *default packet size* is 4096 bytes. The default value for this parameter is 128 bytes.

Related configuration parameters are:

- National Set Packet Size Default
- National Set Packet Size Maximum

## Configuring the X.25 Network Interface

### Maximum Packet Size

Specifies the maximum negotiable packet size for SVCs. This value must be equal to or less than the maximum packet size specified with the **national set packet-size** command. The default value for this parameter is 256 bytes. The maximum value that can be configured for this parameter is 4096 bytes. This value is utilized in calculating the maximum frame size for this X.25 interface.

Related configuration parameters are:

- National Set Packet Size Default
- National Set Packet Size Maximum

### Circuit Idle Time

Specifies the number of seconds that an SVC can be idle before it is cleared by the router. The range is 0 to 65365. The default is 30 seconds. A 0 (zero) specifies that the circuit is never cleared by the router.

### Maximum VCs

Specifies the maximum number of circuits that are open to the same DTE address for a protocol. Refer to RFC 1356 for information on utilizing this parameter. The Valid range is 1 to 10. The default is 4.

### pref CUG, CUG, pref bi-cug, bi-cug

See **add address** command.

### The following are QLLC unique parameters:

#### QLLC response timer

The number of seconds to wait for a Q-response packet before retransmitting.

#### QLLC response count

The maximum number of times QLLC will retransmit. Upon exhausting this number of retries, the upper layer is notified which may result in the circuit being cleared or reset by the router.

### Accept Reverse Charges

Allows this protocol to override the setting of this National Personality parameter. This does not affect the National Personality parameter.

### Request Reverse Charges

Allows this protocol to override the setting of this National Personality parameter. This does not affect the National Personality parameter.

### Station Type

Specifies the default station type for this protocol:

- Pri** Primary Station
- Sec** Secondary Station
- Peer** Peer Station

### Max message size

The maximum message size for this protocol. Specify a value that is less than, or equal to, the Max MTU size of the interface.

## Configuring the X.25 Network Interface

### Call User Data

Specifies the default CUD field used in call packets for this protocol. Specify from 1-to-16 characters. If you do not specify characters, the default 0xC3 is used.

**pvc** Adds PVC, window size, and packet size definitions.

### Example: add pvc

#### IP example:

```
Protocol [IP]? IP
Packet Channel Range Start [1]?
Destination X.25 Address[]?
Packet Channel Range End [1]?
Window Size [2]?
Packet Size [128]?
```

#### Protocol

Specifies which protocol's encapsulation you want to modify: APPN, XTP, DECnet, Banyan Vines, DLSw, IP or IPX. The default is IP.

#### Packet Channel Range Start

Specifies the starting circuit number of this range of PVCs.

#### Packet Channel Range End

Specifies the last circuit number of this range of PVCs. Defaults to the value of the Packet Channel Range Start.

#### Destination X.25 Address

Specifies the X.25 address of the PVC's destination.

#### Remote Address

Specifies the remote address for caller ID on received calls.

#### Window Size

Specifies the number of packets that can be outstanding before requiring packet confirmation. The default is 2.

Related configuration parameters are:

- Set Default Window

#### Packet Size

Specifies the maximum negotiable packet size for PVCs. This value must be equal to or less than the maximum packet size specified with the **national set packet-size** command. The default value for this parameter is 128 bytes. The maximum value that may be configured for this parameter is 4096 bytes. The maximum for X.31 is 256 bytes. This value is utilized in calculating the maximum frame size for this X.25 interface.

Related configuration parameters are:

- Nat Set Packet Size Default
- Nat Set Packet Size Maximum

## Change

Use the **change** command to change an X.121 address, an DDN X.25 Address, a protocol configuration, or a PVC definition.

**Note:** To change an IP address that is associated with an X.121 address, you must delete the record that contains the address correlation, then redefine the address mapping.



## Configuring the X.25 Network Interface

### Syntax:

```
change                address  
                        htf-address  
                        protocol  
                        pvc
```

### address

Modifies a X.121 address translation. The prompts that appear depend on the protocol that is changing.

#### Example: change address

##### IP example:

```
Protocol [IP] IP  
IP Address [0.0.0.0]?  
Enc Priority []?  
X.25 Address [00000124040000]?
```

##### IPX example:

```
Protocol [IP] IPX  
CUD Field Usage (Standard or Proprietary) [Standard]?  
IPX Host number (in hex) []?  
Enc Priority []?  
X.25 Address [00000124040000]?
```

### htf address

Changes a Defense Data Network (DDN) X.25 address translation.

#### Example:

```
change htf-address  
Protocol [IP]  
Change HTF address [0.0.0.0]?  
New HTF address [10.4.0.124]?
```

### protocol

Changes a protocol configuration definition.

#### Example:

```
change protocol  
Protocol [IP]  
Window Size [2]  
Default Packet Size [128]  
Maximum Packet Size [256]  
Circuit Idle Time [30]  
Maximum VCs [6]
```

#### QLLC example:

```
X.25 Config> change prot  
Protocol [IP]? dls  
Idle Timer [30]?  
QLLC response timer (in decaseconds) [15]?  
QLLC response count [255]?  
Accept Reverse Charges [N]?  
Request Reverse Charges [N]?  
Station Type (1) PRI (2) SEC (3) PEER [3]?  
Max Packet Size [256]?  
Packet Window size [7]?  
Max message size [2048]?  
Call User Data (in HEX, 0 for Null) []? C3010000525450
```

**pvc** Changes PVC, window size, and packet size definitions.

**Note:** To change the protocol, packet channel or destination X.25 address, you must delete the record which contains the definition, then add it

## Configuring the X.25 Network Interface

back with the changed parameters. A change will apply to *all* PVCs in the range of circuits defined by the Packet Channel Range Start parameter.

### Example:

```
change pvc
Protocol [IP]? IP
Packet Channel Range Start[1]?
Destination X.25 Address [ ]?
Packet Channel Range End [1]
Window Size [2]?
Packet Size [128]?
```

## Delete

Use the **delete** command to delete an X.121 address, a protocol configuration definition, or a PVC definition.

### Syntax:

```
delete                address
                        bi-cugs
                        cugs
                        protocol . . .
                        pvc
```

### address

Deletes an X.121 address translation.

### Example: delete address

#### IP example:

```
Protocol [IP]?
IP Address [0.0.0.0]?
```

#### IPX example:

```
Protocol [IP]? IPX
IPX Host Number (in hex) [2]?
```

### bi-cugs

Deletes a bilateral closed user group number used by this interface.

#### Valid values:

- Y** Deletes the current CUG.
- N** Does not delete the current CUG.
- ALL** Deletes all remaining CUGs.
- Q** Stops deleting any remaining CUGs.

#### Example:

```
delete bi-cugs
Delete Pref BI-CUG [Y]?
Delete BI-CUG (2) [Y]? N
Delete BI-CUG (3) [Y]? q
```

**cugs** Deletes the closed user group numbers used by this interface. This command works similar to the **delete bi-cug** command.

#### Example:

## Configuring the X.25 Network Interface

```
del cug
Delete Pref CUG [Y]?
Delete CUG (2) [Y]?
Delete CUG (3) [Y]? q
```

### protocol *prot-type*

Deletes a protocol encapsulation configuration definition. *Prot-type* is the name or number of the protocol encapsulation that is currently defined in the router's configuration.

**pvc** Deletes a PVC definition. All PVCs in the range of circuits defined by the Packet Channel Range Start parameter will be deleted.

### Example:

```
delete pvc
Protocol [IP]?
Destination X.25 Address [ ]?
Packet Channel Range Start [ ]?
```

## List

Use the **list** command to display the current configuration for the specified parameter.

### Syntax:

```
list address
      all
      cugs
      detailed
      protocols
      pvc
      summary
```

### address

Lists all the X.121 address translations.

### Example:

```
list address
IF#      Prot #      Active Enc      Protocol ->      X.25 address
1        0(IP)        CC              10.1.2.3 ->      1238765742
1        7(IPX)        SNAP           10              ->      12389
                CUGS: 11 12 13 14 15          BI-CUGS: 21 22
```

**all** Lists all the X.25 addresses, National Personality parameters, all defined protocols and their values, and all defined PVCs.

### Example:

```
list all
X.25 Configuration Summary
Node Address:          313131
Max Calls Out:         4
Inter-Frame Delay:    0      Encoding: NRZ
Speed:                 64000   Clocking: Internal
MTU:                   2048    Cable: V.35 DCE
Lower DTR: Disabled
Default Window:       2      SVC idle: 30 seconds
National Personality: GTE Telenet (DTE)
PVC                    low: 1   high: 1
Inbound                low: 0   high: 0
Two-Way                low: 2   high: 64
Outbound               low: 0   high: 0
```

## Configuring the X.25 Network Interface

```
Throughput Class in bps Inbound: 2400
Throughput Class in bps Outbound: 2400
```

### X.25 National Personality Configuration

```
Request Reverse Charges: on Accept Reverse Charges: on
Frame Extended seq mode: off Packet Extended seq mode: off
Incoming Calls Barred: off Outgoing Calls Barred: off
Throughput Negotiation: on Flow Control Negotiation: on
Suppress Calling Addresses: off DDN Address Translation: off
Truncate Called Addresses: off
Number of digits to truncate called addresses to: 2
CUG Support: off BI-CUG Support: off
CUG Outgoing Access: off CUG Incoming Access : off
BI-CUG Outgoing Access: off CUG 0 Override: off
CUG Isertion: off CUG deletion: off
Call Request Timer: 20 decaseconds
Clear Request Timer: 18 decaseconds (1 retries)
Reset Request Timer: 18 decaseconds (1 retries)
Restart Request Timer: 18 decaseconds (1 retries)
Min Recall Timer 10 seconds
Min Connect Timer 90 seconds
Collision Timer 5 seconds
T1 Timer: 4.00 seconds N2 timeouts: 20
T2 Timer: 2.00 seconds DP Timer: 500 milliseconds
Standard Version: 1984 Network Type: CCITT
Disconnect Procedure: passive
Window Size Frame: 7 Packet: 2
Packet Size Default: 128 Maximum: 256
```

### X.25 protocol configuration

No protocols defined

### X.25 PVC configuration

No PVCs defined

X.25 address translation configuration  
No address translations defined

**cugs** Lists the CUG and BI-CUG numbers for each X.25 interface in this device.

#### Example:

```
1i cugs
CUGS: 23 24 25 26 27
```

#### detailed

Lists the value of all the default parameters that the **national set** command modifies. Descriptions of the screen display are listed in the **national set** command described later in this chapter.

#### Example:

##### list detail

### X.25 National Personality Configuration

```
Follow CCITT: on OSI 1984: on OSI 1988: off
Request Reverse Charges: off Accept Reverse Charges: off
Frame Extended seq mode: off Packet Extended seq mode: off
Incoming Calls Barred: off Outgoing Calls Barred: off
Throughput Negotiation: on Flow Control Negotiation: off
Suppress Calling Addresses: off DDN Address Translation: off
Truncate Called Addresses: off
Number of digits to truncate called address to: 2
CUG Support: off BI-CUG Support: off
CUG Outgoing Access: off CUG Incoming Access : off
BI-CUG Outgoing Access: off CUG 0 Override: off
CUG Isertion: off CUG deletion: off
T21 (Call Request Timer): 20 decaseconds
T23 (Clear Request Timer): 18 decaseconds (1 retries)
T22 (Reset Request Timer): 18 decaseconds (1 retries)
T20 (Restart Request Timer): 18 decaseconds (1 retries)
Min Recall Timer: 10 seconds
Min Connect Timer: 90 seconds
Collision Timer: 8 seconds
```

## Configuring the X.25 Network Interface

```
T1 Timer: 4.00 seconds      N2 timeouts: 20
T2 Timer: 0.00 seconds      DP Timer: 500 milliseconds
Standard Version: 1984      Network Type: CCITT
Disconnect Procedure: active
Window Size      Frame: 7      Packet: 2
Packet Size      Default: 256    Maximum: 256
```

### protocols

Lists all the defined protocol configurations. See “Add” on page 452 for a description of the parameters.

#### Example:

```
list protocols
```

```
X.25 protocol configuration
```

Protocol Number	Window Size	Packet-Size Default	Packet-Size Maximum	Idle Time	Max VCs
0(IP)	2	128	256	30	4

CUGS: 11 12 13 14 15      BI-CUGS: 21 22

```
QLLC Protocols
```

Protocol Number	Packet Window	Packet MaxSize	Idle Time	Response Timer	Response Count	Reverse Charges Accept	Reverse Charges Request	Max Message	Station Type
26(DLSW)	7	256	30	15	255	N	N	2048	PEER

CUD : [C3 01 00 00 52 54 50 ]  
CUGS: 11 12 13 14 15      BI-CUGS: 21 22

**pvc** Lists all the defined PVCs.

#### Example:

```
list pvc
```

```
X.25 PVC configuration
```

Prtcl	X.25 Address	Active	Enc	Window	Pkt_len	Pkt_chan
0	8383838383	CC		4	1024	3 - 3

### summary

Lists all the values established by the **set** and **enable** commands. These values modify the X.25 configuration.

#### Example:

```
list summary
```

```
X.25 Configuration Summary
```

```
Node Address: 313131
Max Calls Out: 4
Inter-Frame Delay: 0      Encoding: NRZ
Speed: 64000              Clocking: Internal
MTU: 2048                 Cable: V.35 DCE
Lower DTR: Disabled
Default Window: 2         SVC idle: 30 seconds
National Personality: GTE Telenet (DTE)
PVC low: 1 high: 1
Inbound low: 0 high: 0
Two-Way low: 2 high: 64
Outbound low: 0 high: 0
Throughput Class in bps Inbound: 2400
Throughput Class in bps Outbound: 2400
```

---

## Accessing the Interface Monitoring Process

To monitor information related to the X.25 network interface, access the interface monitoring process as follows:

1. At the OPCON prompt, enter **talk 5**. For example:

```
* talk 5
+
```

## Configuring the X.25 Network Interface

The GWCON prompt (+) is displayed on the console. If the prompt does not appear when you first enter GWCON, press **Return** again.

- At the GWCON prompt, enter the **configuration** command to see the protocols and networks for which the router is configured. For example:

```
+ configuration
```

See page “Configuration” on page 112 for sample output of the **configuration** command.

- Enter the **network** command and the number of the X.25 interface.

```
+ network 2  
X.25>
```

The X.25 monitoring prompt is displayed on the console. You can then view information about the X.25 interface by entering the X.25 monitoring commands.

---

## X.25 Monitoring Commands

This section summarizes and explains all the X.25 monitoring commands. The X.25 monitoring commands allow you to view the parameters and statistics of the interfaces and networks that transmit X.25 packets. Monitoring commands display configuration values for the physical, frame, and packet levels. You also have the option of viewing the values for all three protocol levels at once.

Enter the X.25 monitoring commands at the X.25> prompt. Table 65 shows the commands.

*Table 65. X.25 Monitoring Command Summary*

Monitoring Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Lists individual PVC or SVC statistics and general information.
Parameters	Displays the current parameters for any level of the X.25 configuration.
Reset	Resets the dly-recall and min-recall timers for all peers on this interface, or resets timers for a specific destination by entering the X.25 destination address. This will allow the calling sequence to start over.
Statistics	Displays the current statistics for any level of the X.25 configuration.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## List

Use the **list** command to display the current active PVCs and SVCs.

### Syntax:

```
list                pvcs  
                    svcs
```

**pvc** Displays the configured permanent virtual circuits.

**svc** Displays the active switched virtual circuits.

### Example:

```
list svc
```

```
LCN/ Destination Originate Transmits Protocol Totals  
State Address Call Queued Encapsulated Xmts Rcvrs Resets
```

## Configuring the X.25 Network Interface

13	D	898280077113	YES	0	IP	8943	261	1
20	D	898280077114	NO	0	IP	943	43	0
42	P	898280077116	YES	6	IP	0	0	0
23	C	898280077117	YES	0	IP	3054	110	0

D - Data Transfer      P - Call Progressing  
C - Call Clearing

## Parameters

Use the **parameters** command to display the current parameters for any level of the X.25 configuration.

### Syntax:

```
parameters                    all  
                                  frame  
                                  packet  
                                  physical
```

**all**      Displays the parameters for the packet, frame, and physical levels.

**frame**    Displays the parameters for the frame level.

### Example:

```
parameters frame  
Frame Layer Parameters:  
Maximum Frame Size = 262 Maximum Window Size = 7  
Protocol Enabled = YES Equipment Type = DTE  
T1 Retransmit Timer = 4 T2 Acknowledge Timer = 2  
N2 Retry Counter = 20 Disconnect Procedure = PASSIVE  
Disconnect Timer = 500 Network Type = GTE  
Protocol Options: Inhibit Idle RRs No MOD 128 NO Enable SARM NO
```

### packet

Displays the parameters for the packet level.

### Example:

```
parameters packet  
Packet Layer Parameters:  
Default Packet Size = 128 Maximum Packet Size = 256  
Log 2 Packet size = 2 Acknowledge Delay = 0  
Layer Enabled = YES Default Window Size = 2  
Lowest SVC = 1 Highest SVC = 64  
Lowest PVC = 0 Highest PVC = 0  
T20 (Restart) = 18 R20 (Retry) = 1  
T21 (Call) = 20  
T22 (Reset) = 18 R22 (Retry) = 1  
T23 (Clear) = 18 R23 (Retry) = 1  
Network Type = GTE Equipment Type = DTE
```

### physical

Displays the parameters for the physical level.

### Example:

```
parameters physical  
Physical Layer Parameters:  
Interface Type = V.35  
  
Maximum Frame Size = 264 InterFrame Delay = 2  
Configured Speed = 0 Clocking = External  
Encoding = NRZ  
Protocol Enabled = Yes
```

## Reset

Use the **reset** command to reset the dly-recall or min-recall timer and restart the calling attempts for all X.25 destinations or for a particular X.25 destination.

### Syntax:

## Configuring the X.25 Network Interface

reset all-peer-recall-tmrs  
peer-recall-tmr

### all-peer-recall-tmrs

Resets the calling sequence for all X.25 destinations (peers) on this interface. So, if a destination was in the middle of dly-recall, this can be used to reset the timer and start the sequence over.

#### Example: reset all-peer

This command will return one of the following messages:

- Reset delay recall timers completed.
- No recall timers running for this net.
- No peers located for this net.

### peer-recall-tmr

Resets the calling sequence for a particular X.25 destination (peer) on this interface. Enter the X.25 destination to be reset.

#### Example 1: reset peer-recall-tmr

```
reset peer-recall-tmr
Enter X.25 address: 89828007713
```

This command will return one of the following messages:

- Reset delay recall timers completed.
- No recall timers running for this net.

#### Example 2: reset peer-recall-tmr 89828007713

```
reset peer-recall-tmr 89828007713
```

This command will return one of the following messages:

- Reset delay recall timers completed.
- No recall timers running for this net.

## Statistics

Use the **statistics** command to display the current statistics of any level of the X.25 configuration.

### Syntax:

#### statistics

all  
frame  
packet  
physical

**all** Displays the statistics for the packet, frame, and physical levels.

**frame** Displays the statistics for the frame level.

#### Example:

```
statistics frame
Frame Layer Counters:   Received          Transmitted
Information Frames     0                  0
RR Command             0                  0
RR Response            0                  0
RNR Command            0                  0
RNR Response           0                  0
REJ Command            0                  0
REJ Response           0                  0
```



## Configuring the X.25 Network Interface

```
SABM                0                71
SABME                0                0
UA                  0                0
DISC                 0                0
DM                   0                0
FRMR                 0                0
Total Bytes         0                0
Frame Layer Miscellaneous:
Queued Output Frames = 0 Protocol Layer State = Link Setup
Send Sequence N(S) = 0 Receive Sequence N(R)= 0
```

### packet

Displays the statistics for the packet level.

#### Example:

```
statistics packet
Packet Counters:      Received      Transmitted
Call Request          0                0
Call Accepted         0                0
Clear Request         0                0
Clear Confirm         0                0
Interrupt Request     0                0
Interrupt Confirm     0                0
RR Packet             0                0
RNR Packet            0                0

Reset Request         0                0
Reset Confirm         0                0
Restart Request       0                0
Restart Confirm       0                0
Diagnostic            0                0
Data Packet           0                0
Data Bytes            0                0
Buffers Queued        0                0
Invalid Packets Received = 0
Switched Circuits Opened = 0
```

### physical

Displays the statistics for the physical level.

#### Example:

```
statistics physical
X.25 Physical Layer Counters:
Rx Bytes              0   Tx Bytes              0

Adapter cable:        V.35 DTE

Nicknames:   RTS CTS DSR DTR DCD
PUB 41450:   CA CB  CC CD  CF
State:       ON ON  ON ON  ON

Line speed:         unknown
Last port reset:    12 minutes, 21 seconds ago

Input frame errors:
CRC error           0   alignment (byte length)   0
missed frame        0   too long (> 0 bytes)     0
aborted frame       0   DMA/FIFO overrun         0

Output frame counters:
DMA/FIFO underrun errors  0   Output aborts sent       0
```

---

## X.25 Network Interfaces and the GWCON Interface Command

While X.25 interfaces have their own monitoring processes for monitoring purposes, the router also displays complete statistics for installed network interfaces when you use the **interface** command from the GWCON environment. (For more information on the **interface** command, refer to Chapter 8, The Operating/Monitoring Process (GWCON - Talk 5) and Commands).

### Statistics Displayed for X.25 Interfaces

The following statistics display when you run the **interface** command from the GWCON environment for X.25 interfaces:

```
+interface 11
Nt Nt' Interface Slot-Port                Self-Test Self-Test Maintenance
Passed Failed Failed
```

## Configuring the X.25 Network Interface

```

11 11  X25/0      Slot: 8 Port: 1                1      0      0

X.25 MAC/data-link on V.35/V.36 interface
Interface State: DCD CTS Packet Layer Frame Layer
                  ON  ON      UP      UP
Packet Counters:      Received      Transmitted
Data Packet           0              353
Data Bytes            0             18888
Buffers Queued        0              0
Invalid Packets Received =
Switched Circuits Opened =          0

Frame Layer Counters:      Received      Transmitted
Information Frames        354            354

X.25 Physical Layer Counters:
Rx Bytes                 3316 Tx Bytes           22204

Adapter cable:           V.35 DTE

V.24 circuit: 105 106 107 108 109
Nicknames:      RTS CTS DSR DTR DCD
PUB 41450:     CA CB CC CD CF
State:          ON ON ON ON ON

Line speed:           64.000 kbps
Last port reset:     1 hour, 20 minutes, 25 seconds ago

Input frame errors:
CRC error            0 alignment (byte length)      0
missed frame         0 too long (> 2057 bytes)    0
aborted frame        0 DMA/FIFO overrun          0
Output frame counters:
DMA/FIFO underrun errors 0 Output aborts sent      0
Interface buffer pool: Total = 57, Free = 56

```

The following list describes the interface statistics:

**Nt** Global interface number

**Nt '** Reserved for future dial circuit use

### Interface

Interface name and number (within interfaces of the same type)

**Slot** Slot number of interface

**Port** Port number of interface

### Self-Test Passed

Number of times self-test succeeded

### Self-Test Failed

Number of times self-test failed

### Maintenance Failed

Number of maintenance failures

### Interface state

Display the current state of the input modem control signals, the packet layer (X.25 Layer 3), and the frame layer (X.25 Layer 2).

### Packet Counters

Provides statistics on packets received and transmitted.

### Data Packets

Displays the number of data packets the interface transmits receives on the network

### Data Bytes

Displays the number of data bytes the interface transmits receives on the network.

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### **Buffers Queued**

Displays the number of buffers currently queued for transmission over the network. These may be frame or packet layer supervisory messages as well as forwarder packets.

### **Invalid Packets Received**

Displays the number of invalid X.25 packets received from the network.

### **Switched Circuits Open**

Displays the number of switched circuits currently open.

### **Frame Layer Counters**

Provides statistics generated from Frame Layer counters.

### **Information Frames**

Displays the number of X.25 Information frames the interface has transmitted and received.

### **X.25 Physical Layer Counters**

Provides statistics generated from Physical Layer counters.

### **RX Bytes**

Display the number of bytes received by the Physical layer.

### **TX Bytes**

Displays the number of bytes transmitted by the Physical layer.

### **Line speed**

The transmit clock rate.

### **Last port reset**

The length of time since the last port reset.

### **Input frame errors:**

#### **CRC error**

The number of packets received that contained checksum errors and as a result were discarded.

#### **Alignment**

The number of packets received that were not an even multiple of 8 bits in length and as a result were discarded.

#### **Too short**

The number of packets that were less than 2 bytes in length and as a result were discarded.

#### **Too long**

The number of packets that were greater than the configured size, and as a result were discarded.

#### **Aborted frame**

The number of packets received that were aborted by the sender or a line error.

#### **DMA/FIFO overrun**

The number of times the serial interface card could not send data fast enough to the system packet buffer memory to receive them from the network.

#### **Missed frame**

When a frame arrives at the device and there is no buffer available, the hardware drops the frame and increments the missed frame counter.

## Configuring the X.25 Network Interface

### L & F bits not set

On serial interfaces, the hardware sets input-descriptor information for arriving frames. If the buffer can accept the complete frame upon arrival, the hardware sets both the last and first bits of the frame, indicating that the buffer accepted the complete frame. If either of the bits is not set, the packet is dropped, the L & F bits not set counter is incremented, and the buffer is cleared for reuse.

**Note:** It is unlikely that the L & F bits not set counter will be affected by traffic.

### Output frame counters:

#### DMA/FIFO underrun errors

The number of times the serial interface card could not retrieve data fast enough from the system packet buffer memory to transmit them onto the network.

#### Output aborts sent

The number of transmissions that were aborted as requested by upper-level software.

---

## X.25 Network Interface Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

X.25 network interface supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

### GWCON (Talk 5) Activate Interface

X.25 network interface supports the GWCON (Talk 5) **activate interface** command with the following considerations:

- Only ISDN D-channel dial circuit is supported for X.25.
- You cannot activate an X.25 dial circuit if its base net is not already active.

All X.25 network interface interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

### GWCON (Talk 5) Reset Interface

X.25 network interface supports the GWCON (Talk 5) **reset interface** command with the following considerations:

- An X.25 dial circuit cannot be reset if any of the dial circuit parameters that are configured at the Dial Circuit config prompt have changed (This only applies to X.31 for X.25).
- You cannot reset an X.25 interface that has had the MTU size increased from its original startup value.
- You cannot reset an X.25 interface that has modified XTP configuration and has XTP being used on that interface.

All X.25 network interface configuration changes are automatically activated except the following:

## Configuring the X.25 Network Interface

<b>Commands whose changes are not activated by the GWCON (Talk 5) reset interface command</b>
---

CONFIG, net, set mtu
----------------------

<b>Note:</b> You cannot increase the mtu size.
--

## Configuring the X.25 Network Interface

---

## Chapter 39. Using XTP

This chapter describes the X.25 Transport Protocol (XTP) for transporting X.25 traffic over TCP/IP. Included are the following sections:

- “The X.25 Transport Protocol”
- “DTE Address Wildcards” on page 475
- “XTP Backup Peer Function” on page 476
- “Local XTP” on page 477
- “XTP and Closed User Groups” on page 477
- “Configuring XTP” on page 477
- “Configuration Procedures” on page 477

---

### The X.25 Transport Protocol

X.25 Transport Protocol (XTP) provides you with the services of a “protocol forwarder.” A protocol forwarder is the focal point for inbound and outbound protocol packet processing. Forwarders receive packets on one network interface and send them to another interface.

XTP is designed to work with X.25 devices that are situated at multiple remote sites. In such environments, XTP can eliminate the use of X.25 packet-switched networks for communicating with servers at one or more centralized locations.

To enable this, you use routers at the server and remote locations to encapsulate the data and deliver the X.25 packets between the clients and server via TCP/IP.

Figure 36 on page 474 illustrates a network configuration before and after using XTP.

## Using XTP

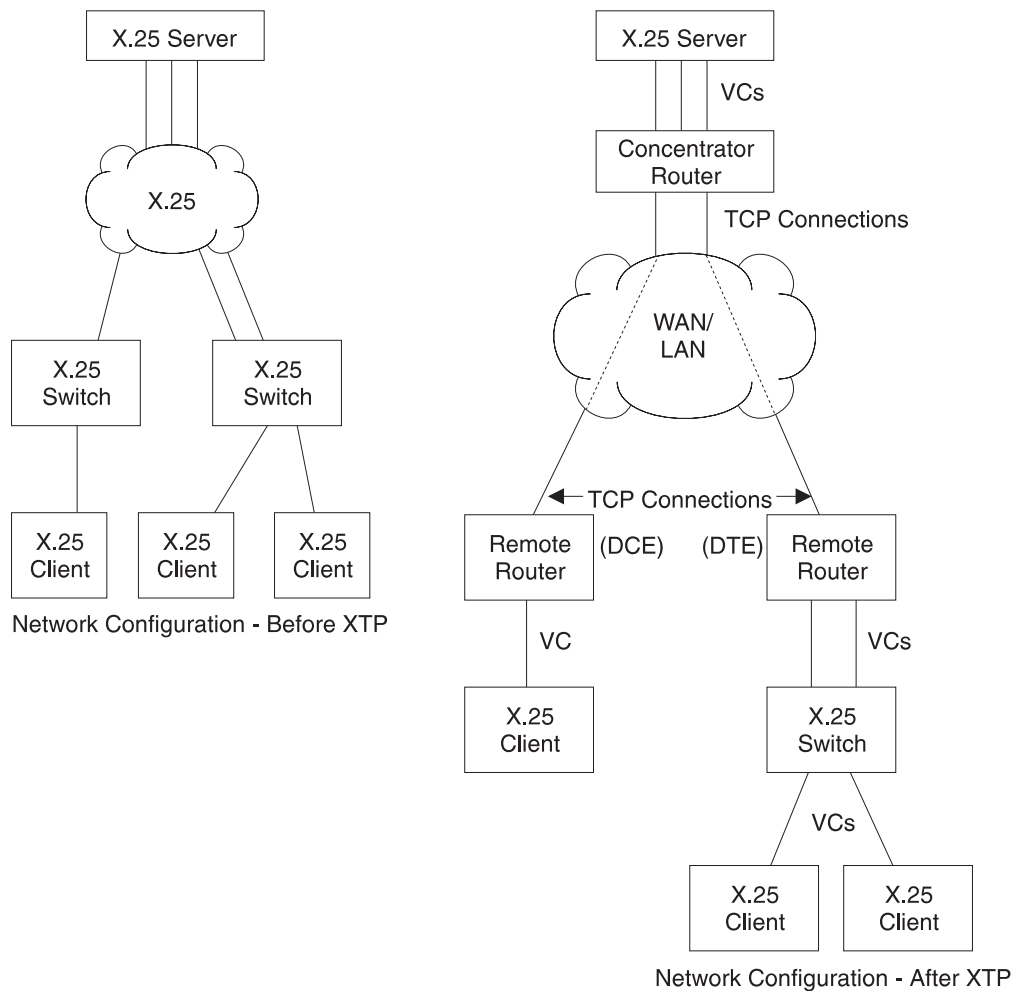


Figure 36. Configuration Before and After XTP

## Configuration Information

X.25 recognizes an incoming call for XTP based on the node addresses configured for XTP. Therefore, in order to transport X.25 traffic between the X.25 nodes, you must configure X.25 to map to the data terminal equipment (DTE) address and IP addresses of the routers to which the nodes are connected.

For example, in Figure 36, you configure X.25 clients on remote routers and on the concentrator router. *Remote routers* in this example are the routers that connect the X.25 clients to the TCP/IP network that is used to access the X.25 server; the *concentrator router* connects the X.25 server to the TCP/IP network that is used to access the remote routers.

**Note:** When you configure XTP, if a router is connected to an X.25 switch, it is considered to be DTE. If it is not connected to a switch, it is considered to be DCE (Data Circuit-Terminating Equipment).

To configure a router for XTP, define the following information from the XTP config> prompt and then restart the router:

- Local DTEs
- Peer routers
- Remote DTEs



- PVCs
- CUGs

### Local DTEs

X.25 nodes connected to the X.25 interfaces on the router

To configure local DTEs, use the X.121 address that is assigned to the local DTE. Multiple local DTEs can be configured on an interface.

### Peer Routers

Routers with which you communicate over TCP/IP

Peer routers can differ depending on “point of view”. For example, in Figure 36 on page 474, the *two remote routers* are the peer routers from the perspective of the concentrator router. However, the *concentrator router* is the peer router from the perspective of the two remote routers.

You designate the peer router by its internal IP address.

### Remote DTEs

Remote X.25 nodes to which the local X.25 nodes open connections and exchange data. Use the X.121 address that is assigned to the remote DTE.

Configure a *unique* IP address for each peer router. For example, in Figure 36 on page 474, the concentrator router must know the unique IP address of each remote router, and each remote router must know the IP address of the concentrator router.

**PVC** A permanent channel that remains connected after X.25 restarts.

PVCs, because they are constant channels, are similar to leased telephone lines. A PVC, in the XTP context, is a PVC from a local X.25 DTE node to a remote X.25 DTE.

When you configure a router for PVCs, map the IP address of the peer router and the PVC number of the remote and local DTE. A PVC is identified by four pieces of information which are the:

- Logical channel numbers of the local PVCs
- X.121 address of the local DTE
- Logical channel numbers of the PVCs on the remote (peer) router
- X.121 address of the remote DTE

**CUGS** The closed user groups for the XTP protocol. See “Understanding Closed User Groups” on page 433.

Additional configuration information can be found at “Configuring XTP” on page 477 and at “XTP Configuring Commands” on page 485.

---

## DTE Address Wildcards

The “\*” wildcard is available for DTE address configuration. This is in addition to the “?” character that can be specified in a DTE address to represent any one digit in that position in the address. For example, a specification of “1?2?3” can match address 18243 where the first, third, and fifth digits are 1, 2, and 3, respectively.

The “\*” wildcard character can represent any string of zero or more digits. Its use is limited to the end of a DTE address specification. For example: “123\*”, “5555\*”, “9\*” or “\*”. The special case of a DTE address of “\*” represents any DTE address, even a null address. The null address is useful for handling incoming calls with no calling address in the X.25 Call Request packet.

## Using XTP

Use of the "\*" wildcard increases the chances for adding a local or a remote DTE address that conflicts with an existing address. The **add local-dte** and **add remote-dte** commands are enhanced to provide the conflicting address when the user attempts to add a DTE address that conflicts with an existing address.

**Example:** xtp config> add local-dte

```
Interface number [0]? 1
DTE address [ ] 123456
DTE address [ ]?
```

```
XTP config>add local-dte
```

```
Interface number [0]?1
DTE address [ ]?1*
DTE address conflicts with existing DTE address 123456
```

---

## XTP Backup Peer Function

The Backup Peer Function allows the association of multiple peer routers with a remote DTE. The user specifies a list of peer routers associated with a remote DTE.

Example:

```
XTP config>add rem
DTE address [ ]?123456
Peer router's internal IP Address [0.0.0.0]?10.0.0.2
Peer router's internal IP Address [0.0.0.0]?10.0.0.4
Peer router's internal IP Address [0.0.0.0]?11.0.0.1
Peer router's internal IP Address [0.0.0.0]?
```

When an incoming call for the remote DTE is received, a connection is attempted through each router in the list in the same order that they appear for the remote DTE.

## Searching for a Remote DTE

When a DTE initiates a call for a remote DTE, both DTE addresses are inspected to determine if they are acceptable for X.25 transport. If they are acceptable, the X.25 Transport protocol forwarder determines through which peer router to attempt to complete the call. It starts with the first router in the remote DTE's list of peer routers in its search. The first condition that must be met is an active TCP connection to the peer router. If there is not an active TCP connection to the peer, the next router in the list is checked. When an active TCP connection is found, an attempt is made to complete the call. The Connection Request Timer is started to time the call connection process.

The remote DTE search is terminated by one of the following events:

- Successful completion of the call through the peer router  
This completes call setup processing and ends the search for the remote DTE.
- Rejection of the call by the peer router  
This causes the search for the remote DTE to proceed to the next router in the peer router list.
- Expiration of the Connection Request Timer  
This causes the search for the remote DTE to proceed to the next router in the peer router list.

If a pass through the list of peer routers is completed without a successful connection through any of the peer routers, the call to the local DTE is cleared.

## Connection Request Timer

The Connection Request Timer is used to ensure that no call setup procedure hangs for an indeterminable time. There is a timer configured for each peer router.

Example:

```
XTP config>add peer-router
Router's internal IP Address [0.0.0.0]?10.0.0.2
Connection setup timeout [230]?60
```

The Connection Request Timer can be configured from 10 to 480 seconds. The default is 230 seconds. This default was determined based on the fact that the default setting for the X.25 Call Request Timer is 200 seconds.

The timer is started when an attempt is made to complete a call through a peer router. It is stopped when the call attempt is either accepted or rejected by the peer router.

## Local XTP

Local XTP allows you to route incoming X.25 traffic to the same or different interfaces on the current router. To configure local XTP, specify the router's internal IP address as a peer address on the **add peer** command.

## XTP and Closed User Groups

XTP supports closed user groups through the local DTE address defined by the **add local** or the **add cug** command. To enable XTP to use closed user groups, you must:

- Enable CUG or BI-CUG on the appropriate X.25 interfaces.
- Supply the XTP protocol-specific CUGs using the **add cug** and **add bi-cug** commands, if desired.
- Supply the appropriate closed user group numbers in the **add local** command. These include:
  - Closed user group number
  - Preferred closed user group number
  - Bilateral closed user group number
  - Preferred bilateral closed user group number
- Enable CUG insertion or deletion for the interface in the **national enable cug\_insertion** or **national enable cug\_deletion** commands, if desired.
- Enable the CUG 0 override option on the **national enable cug 0 override** command, if desired.

## Configuring XTP

XTP is a protocol forwarder used to transport X.25 traffic over TCP/IP. XTP allows existing X.25 devices to communicate over a TCP/IP backbone and migrate from an X.25 network to a network of your choice.

## Configuration Procedures

This section defines the detail for configuring the network displayed in Figure 37 on page 478.

## Using XTP

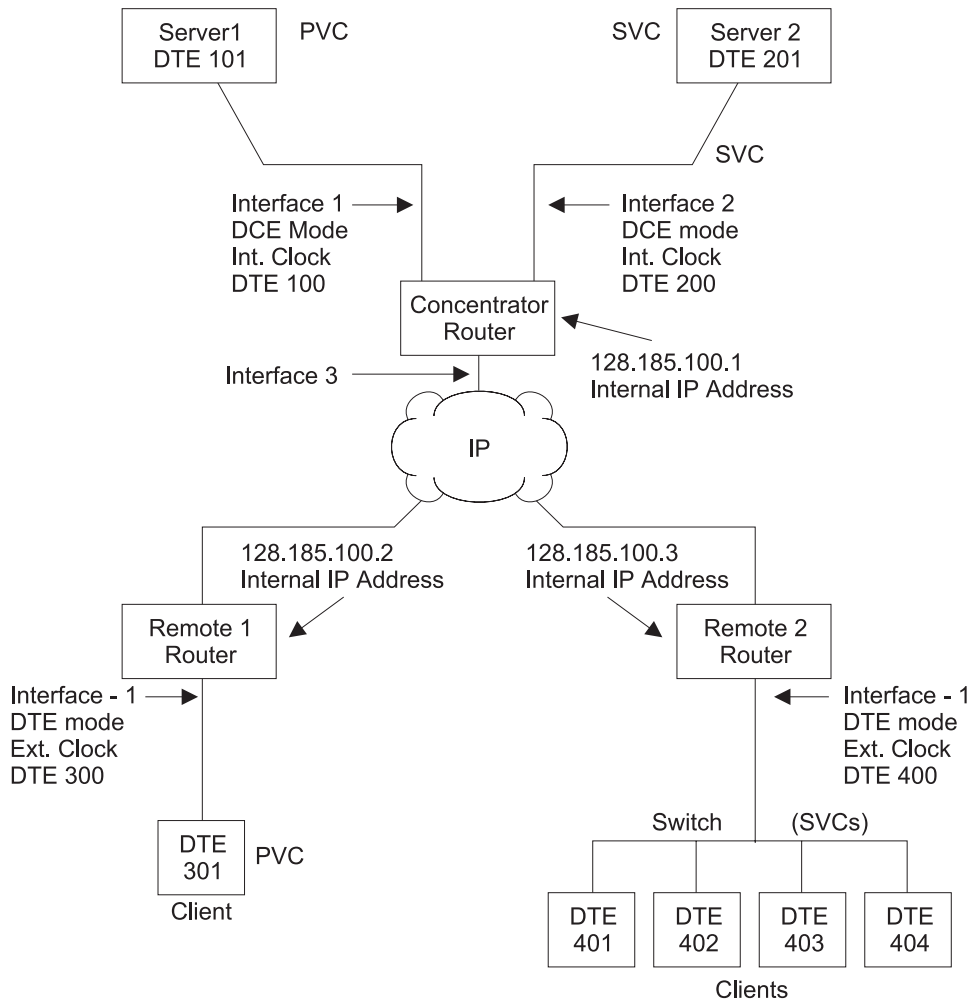


Figure 37. Sample XTP Configuration

This configuration shows three routers, the Concentrator router, Remote 1 router, and Remote 2 router. To make XTP operational on this network, perform the following steps for each of these routers:

- Set the data link
- Configure the IP interface
- Configure X.25
- Set the National Personality values
- Define the IP address
- Set the Internal IP address
- Configure XTP

**Note:** New configurations do not take effect until you restart the router.

## Setting the Data Link

The data link defines the protocol you are using to send data packets over the network. Define the data link between the router you are configuring and each serial interface. The example in Figure 37 configures a concentrator router with three serial interfaces, two for X.25 and one for PPP.

Set the data-link protocol for the serial interfaces:

```
Config>set data-link X25 1
Config>set data-link x25 2
Config>set data-link ppp 3
```

## Configuring the IP Interface

In Figure 37 on page 478, the IP interface is PPP; enter **network 3** at the Config> prompt to configure this PPP interface:

```
Config>network 3
PPP interface configuration
```

**Note:** This procedure does not include details about the configuration of PPP. For details, refer to *Software User's Guide*

## Configuring X.25

Before configuring XTP, configure the X.25 parameters for each interface. The following example configures the basic parameters for X.25 and is based on the topology in Figure 37 on page 478.

The parameters you need to configure depend on your network topology. For details about all the X.25 parameters, refer to *Software User's Guide*

### Interface 1

Use the following instructions to configure *Interface 1* on the concentrator router as defined in Figure 37 on page 478.

1. At the Config> prompt, enter **network** followed by the number of the X.25 interface. In this example, it is interface 1.

```
Config>network 1
X.25 User Configuration
X.25 Config>
```

2. Add the XTP protocol to the X.25 interface and define general interface values. Enter **add protocol xtp** at the X.25 Config> prompt. This command needs to be entered *one time only*.

```
X.25 Config>add protocol xtp
Window Size [2]?
Default Packet Size [128]?
Maximum Packet Size [256]?
```

3. Specify the network address by entering **set address** X.25 node address. In Figure 37 on page 478, the node address (DTE address) is 100.

```
X.25 Config>set address 100
```

4. Enter **set clocking** followed by **internal** or **external** based on your router type.

```
X.25 Config>set clocking internal
```

5. Enter **set speed** followed by the access rate (line speed).

```
X.25 Config>set speed
Access rate in bps [9600]?19200
```

6. Enter **set equipment-type** and specify whether the frame and packet levels act as DCE or DTE.

```
X.25 Config>set equipment-type dce
```

7. Enter **set pvc** and define the lowest and the highest PVC you are using.

```
X.25 Config>set pvc low 1
X.25 Config>set pvc high 1
```

8. Enter **add pvc** to define individual PVCs.

```
X.25 Config>add pvc
Protocol [IP]?xtp
Packet Channel [1]?
Destination X.25 Address [ ]?101
Window Size [2]?
Packet Size [128]
```

## Using XTP

9. (Optional) Enter **national enable truncate-called-addresses**. If you want to truncate the called address size, enter **national set truncate-called-addr-size** followed by the number of digits to truncate the called DTE address to.
10. (Optional) Enable CUG support, CUG insertion, and CUG deletion as required.

### Interface 2

Use the following instructions to configure interface 2.

1. At the Config> prompt, enter **network** followed by the number of the X.25 interface. In Figure 37 on page 478, it is 2.

```
Config>network 2
X.25 User Configuration
X.25 Config>
```

2. Use the same procedures as defined in “Interface 1” on page 479 to set the following parameters for interface 2:

- address = 200
- clocking = internal
- speed = 19200
- equipment = dce

3. Enter **set svc** and define the lowest and highest SVC you are using.

There are three types of SVCs: two-way, inbound and outbound. The defaults are “svc low-two-way = 1” and “svc high-two-way = 64.” All other SVC types default to 0. For additional information on SVCs and PVCs, refer to *Software User’s Guide*

```
X.25 Config>set svc ?
X.25 Config>set svc low-inbound 0
X.25 Config>set svc high-inbound 0
X.25 Config>set svc low-outbound 0
X.25 Config>set svc high-outbound 0
X.25 Config>set svc low-two-way 2
X.25 Config>set svc high-two-way 2
```

4. Exit the X.25 Config> prompt.

```
X25 Config>exit
Config>
```

## Setting the National Personality

Each X.25 public network has its own standard configuration. The National Personality refers to a group of 28 variables that define the characteristics of the public data network. These variables provide the router with control information for packets transferred over the link and influence the X.25 facilities used between and XTP router and its local DTE.

All facilities contained in incoming call requests are passed on to the peer router, regardless of whether the local router was configured to support that facility. For example, when packet size negotiation is requested in the incoming call and flow control negotiation is not configured in the router.

The router will insure any packet size and window size being negotiated is within the range specified when defining the X.25 interface. For example, a packet window greater than 7 is negotiated down to 7 if packet-ext-seq-mode has not been defined for the X.25 interface.

To view the configuration values, enter **list detailed** at the X.25 Config> prompt. To set the default values for the national personality, enter **set national-personality** at the X.25 Config> prompt. For further information, refer to *Software User’s Guide*

## Defining the IP Address

Before you configure the Concentrator router (as displayed in Figure 37 on page 478) for XTP, define the IP address for this router. Enter **protocol ip** at the Config> prompt and enter **add address** at the IP config> prompt.

```
Config>protocol ip
IP config>add address
Which net is this address for [0]?3
New address [0.0.0.0]?128.185.100.7
Address mask [255.255.0.0]?255.255.255.0
```

## Setting the Internal IP Address

Each router identifies its peer routers by the internal IP address of the peer routers.

To set the internal IP address of the peer router, enter **set internal IP address** at the IP Config> prompt.

```
IP config>set internal-ip-address
Internal IP address [0.0.0.0]?128.185.100.1
```

## Configuring XTP

After you have configured X.25 and defined the IP address, you are ready to configure XTP for the router.

If you need further configuration information when configuring XTP, see “XTP Configuring Commands” on page 485.

**Note:** When configuring your network for XTP, remember that the peer routers are always the routers you are communicating with over TCP/IP. Therefore, the peer router can differ depending on the point of view. When configuring the routers defined as Remote 1 router and Remote 2 router in Figure 37 on page 478, to them the peer router is the Concentrator router.

Implement the following steps to configure XTP for the router:

1. To access the XTP config> prompt, enter **protocol xtp** at the Config> prompt.
2. Add interface 1 to the XTP configuration. Enter **add local-dte** at the XTP Config> prompt.

```
XTP config>add local-dte
Interface number [0]?1
Allow inbound calls without calling DTE address? (Y or N) [N]? n
DTE address [ ]?101
Pref CUG [ ]? 18
CUG (2) [ ]? 2
CUG (3) [ ]?
Pref BI-CUG [0]?
DTE address [ ]?
```

Entering a null DTE address ends the command input.

3. Add interface 2 to the XTP configuration. Enter **add local-dte** at the XTP Config> prompt.

```
XTP config>add local-dte
Interface number [0]?2
Allow inbound calls without calling DTE address? (Y or N) [N]? n
DTE address [ ]?201
DTE address [ ]?
```

Entering a null DTE address ends the command input.

4. (Optional) Add XTP protocol-specific CUGs.

## Using XTP

```
add cug
  Pref CUG [ ]? 11
  CUG (2) [ ]? 12
  CUG (3) [ ]? 13
  CUG (4) [ ]? 14
  CUG (5) [ ]? 15
```

```
add bi-cug
  Pref BI-CUG [ ]? 21
  BI-CUG (2) [ ]? 22
  BI-CUG (3) [ ]?
```

5. Add Remote 1 router as the peer router. Enter **add peer-router** and enter the IP address of this router.

```
XTP config>add peer-router
Router's internal IP Address [0.0.0.0]?128.185.100.2
Connection setup timeout [230]?
```

6. Add the remote DTE for Remote 1 router. Enter **add remote-dte** and enter the IP and DTE address of this DTE.

```
XTP config>add remote-dte
DTE address [ ]?301
Peer router's internal IP Address [0.0.0.0]?128.185.100.2
Peer router's internal IP Address [0.0.0.0]?
```

**Note:** A remote DTE is *required* only if one of the following applies:

- The Concentrator Router will be initiating XTP connections to the remote DTE due to incoming calls from its local DTEs.
- The DTE is part of an XTP PVC definition.

7. Add Remote 2 router (as the peer router). Enter **add peer-router** and enter the IP address of this router.

```
XTP config>add peer-router
Router's internal IP Address [0.0.0.0]?128.185.100.3
Connection setup timeout [230]?
```

8. Add the remote DTEs for Remote 2 router. Enter **add remote-dte** and enter the IP and DTE addresses of this DTE.

```
XTP config>add remote-dte
DTE address [ ]?401
Peer router's internal IP Address [0.0.0.0]?128.185.100.3
Peer router's internal IP Address [0.0.0.0]?
```

```
XTP config>add remote-dte
DTE address [ ]?402
Peer router's internal IP Address [0.0.0.0]?128.185.100.3
Peer router's internal IP Address [0.0.0.0]?
```

```
XTP config>add remote-dte
DTE address [ ]?403
Peer router's internal IP Address [0.0.0.0]?128.185.100.3
Peer router's internal IP Address [0.0.0.0]?
```

```
XTP config>add remote-dte
DTE address [ ]?404
Peer router's internal IP Address [0.0.0.0]?128.185.100.3
Peer router's internal IP Address [0.0.0.0]?
```

9. Add an XTP PVC to logically associate the local PVC to Server 1 with the remote DTE 301.

```
XTP config>add pvc
Local PVC Range Start [1]?
Local PVC Range End [1]?
Local X.25 DTE address [ ]? 101
Remote PVC Range Start [1]?
Remote PVC Range End [1]?
Remote X.25 DTE address [ ]?301
```

When entering DTE addresses, you can specify either of the following:

- A '?' in place of any digit. The '?' means any single digit in this digit position.
- An '\*' as the last digit of an address to represent any combination of zero or more digits.



## Sample Configuration of Remote Routers

The following is a sample configuration of Remote 1 router and Remote 2 router (see Figure 37 on page 478). The process is the same as that defined in the section at “Configuration Procedures” on page 477.

### Remote 1 router

```
*talk 6

Config>set data-link x25 1
Config>set data-link ppp 2
Config>network 1

X.25 Config>set address 300
X.25 Config>set clocking internal
X.25 Config>set speed 19200
X.25 Config>set equipment-type dce
X.25 Config>set pvc low 1
X.25 Config>set pvc high 1
X.25 Config>add pvc
Protocol [IP]?xtp
Packet Channel [1]?1
Destination X.25 Address [ ]?301

Window Size [2]?
Packet Size [128]?
X.25 Config>exit
Config>

Config>protocol ip
IP config>add address
Which net is this address for [0]?2
New address [0.0.0.0]?128.185.100.8
Address mask [255.255.0.0]?255.255.255.0

IP config>set internal-ip-address
Internal IP address [0.0.0.0]?128.185.100.2
IP Config>exit
Config>

Config>protocol xtp
XTP config>add local-dte
Interface number [0]?1
Allow inbound calls without calling DTE address? (Y or N) [N]? n
DTE address [ ]?301
DTE address [ ]?

XTP config>add peer-router
Router's IP address?128.185.100.1

XTP config>add remote-dte
DTE address [ ]?101
Peer router's internal IP Address ]0.0.0.0]?128.185.100.1
Peer router's internal IP Address [0.0.0.0]?

XTP config>add pvc
Local PVC Range Start [1]?
Local PVC Range End [1]?
Local X.25 DTE address [ ]? 101
Remote PVC Range Start [1]?
Remote PVC Range End [1]?
Remote X.25 DTE address [ ]? 301
```

### Remote 2 router

```
*talk 6

Config>set data-link x25 1
Config>set data-link ppp 2
Config>network 1

X.25 Config>set address 400
X.25 Config>set clocking external
X.25 Config>set speed 19200
X.25 Config>set equipment-type dte
X.25 Config>set svc low-inbound 0
```

## Using XTP

```
X.25 Config>set svc high-inbound 0
X.25 Config>set svc low-outbound 0
X.25 Config>set svc high-outbound 0
X.25 Config>set svc low-two-way 1
X.25 Config>set svc high-two-way 64
X.25 Config>add protocol
Protocol [IP]?xtp
Window Size [2]?
Default Packet Size [128]?
Maximum Packet Size [256]?
X.25 Config>exit

Config>protocol ip
IP config>add address
Which net is this address for [0]?2
New address [0.0.0.0]?128.185.100.9
Address mask [255.255.0.0]?255.255.255.0

IP config>set internal-ip-address
Internal IP address [0.0.0.0]?128.185.100.3
IP Config>exit
Config>

Config>protocol xtp
XTP config>add local-dte
Interface number [0]?1
Allow inbound calls without calling DTE address? (Y or N) [N]? n
DTE address [ ]?401
Pref CUG [ ]? 23
CUG (2) [ ]? 24
CUG (3) [ ]? 25
CUG (4) [ ]? 26
CUG (5) [ ]? 27

DTE address [ ]?402
Pref CUG [ ]?
DTE address [ ]?403
Pref CUG [ ]?
DTE address [ ]?404
Pref CUG [ ]?
DTE address [ ]?

XTP Config>add peer-router
Router's IP address?128.185.100.1

XTP config>add remote-dte
DTE address [ ]?201
Peer router's internal IP Address [0.0.0.0]?128.185.100.1
Peer router's internal IP Address [0.0.0.0]?
XTP config>exit

Config>
```

---

## Chapter 40. Configuring and Monitoring XTP

This chapter describe the XTP configuring and monitoring commands. It includes the following sections:

- “XTP Configuring Commands”
- “XTP Monitoring Commands” on page 491
- “X.25 Network Interface Dynamic Reconfiguration Support” on page 496

---

### XTP Configuring Commands

This section describes the XTP configuring commands.

To access the XTP configuring environment, enter the **protocol xtp** command at the Config> prompt.

```
Config> p xtp
XTP config>
```

Enter the XTP configuring commands at the XTP config> prompt.

*Table 66. XTP Configuration Commands Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Adds an interface, peer router, closed user groups, remote DTE or PVC definitions.
Change	Changes a peer router, remote DTE or PVC definition.
Delete	Deletes a local DTE, peer router, closed user groups, remote DTE or PVC definition.
Enable-XTP	Activates the XTP forwarder.
Disable-XTP	Deactivates the XTP forwarder.
Set	Sets the value of the XTP Keepalive Timer.
List	Lists interfaces, peer routers, remote DTEs and PVC definitions.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Add

Adds a local X.25 node, a peer router, a remote X.25 node with corresponding routers, or a PVC from a local X.25 node to a remote X.25 node.

Wild card addressing is included in the XTP forwarder. When the local or remote DTE addresses are entered, they can contain a wild card character ( ? or \* ). For additional information on the use of wildcards, see “DTE Address Wildcards” on page 475.

#### Syntax:

```
add                bi-cug
                   cug
                   local-dte
                   peer-router
                   remote-dte
                   pvc
```

## XTP Configuring Commands (Talk 6)

**cug** Specifies the closed user group numbers for the XTP protocol. The first CUG you are prompted for is the preferred cug. **Valid values:** 0 to 9999

**Default value:** None

**Example:**

```
add cug
Pref CUG [ ]? 114
CUG (2) [ ]? 314
CUG (3) [ ]? 478
CUG (4) [ ]?
```

**bi-cug** Specifies the bilateral closed user group numbers for the XTP protocol. The first bi-cug you are prompted for is the preferred bi-cug. **Valid values:** 0 to 9999

**Default value:** None

**Example:**

```
add bi-cug
Pref BI-CUG [ ]? 50
BI-CUG (2) [ ]? 51
BI-CUG (3) [ ]? 52
BI-CUG (4) [ ]? 53
BI-CUG (5) [ ]? 54
```

### local-dte

Adds the X.25 DTE addresses, or the X.25 nodes, that communicate with the router on the specified interface. The valid interface numbers for use with XTP are 0 to 255.

You can configure multiple local nodes. However, if the option to allow incoming calls without a calling DTE address has been selected and such a call is received, the *last* local DTE address added becomes the calling DTE address for that call.

**Example:**

```
add local-dte

Interface number [0]?4
Allow inbound calls without calling DTE address? (Y or N) [N]? y
DTE address [ ]?101
Pref CUG [ ]? 23
CUG (2) [ ]? 24
CUG (3) [ ]? 25
CUG (4) [ ]? 26
CUG (5) [ ]? 27
Pref BI-CUG [ ]? 6
BI-CUG (2) [ ]? 7
BI-CUG (3) [ ]? 8
BI-CUG (4) [ ]? 9
BI-CUG (5) [ ]? 10
DTE address [ ]?
```

### peer-router

Adds peer routers. Enter the internal IP addresses of the routers to which the remote X.25 nodes are connected. You can use these IP addresses to open TCP connections and transport X.25 packets that contain connection requests and X.25 data.

If the internal IP address you configure for the peer-router is this router's internal IP address, the software establishes a local XTP connection.

**Example:**

```
add peer-router

Router's internal IP Address [0.0.0.0]?128.185.100.2
Connection setup timeout [230]?
```

## XTP Configuring Commands (Talk 6)

### remote-dte

Adds remote X.25 nodes and corresponding routers. You can connect remote nodes with local X.25 nodes so they can exchange data. You must configure an IP address for each remote X.25 node you configure. Any request or data sent to this remote node goes to the router. The router then uses one of its local X.25 interfaces to forward the data to the X.25 node.

Define a remote DTE if this router is to initiate XTP connections to the remote DTE due to incoming calls from its local DTEs, or if the remote DTE is part of an XTP PVC definition.

To use Local XTP, the peer router address must be the internal address of the local router and that DTE address must be previously defined using the **add local** command.

#### Example:

```
add remote-dte
DTE address [ ]?301
Peer router's internal IP Address [0.0.0.0]?128.185.100.2
Peer router's internal IP Address [0.0.0.0]?
```

### pvc

Adds a PVC from a local X.25 node to a remote X.25 node.

Three things need to exist in order to activate a PVC configuration:

- An X.25 PVC from the router to the local X.25 node
- An X.25 PVC from the peer router to the remote X.25 node
- A TCP connection to the peer router where the remote node is resident

#### Example:

```
XTP config>add pvc
Local PVC Range Start [1]?
Local PVC Range End [1]?
Local X.25 DTE address [ ]? 101
Remote PVC Range Start [1]?
Remote PVC Range End [1]?
Remote X.25 DTE address [ ]? 301
```

#### Notes:

1. When you add PVCs to the router configuration, you also must configure the PVC in X.25. For details on configuring X.25 interfaces, refer to *Software User's Guide*
2. For Local XTP, you must define the PVC in both directions. You need this definition because the router is performing both local and remote functions. For example, to define Local PVC 8 and Remote PVC 10 when you are using Local XTP, you would do the following:

```
XTP config>add pvc
Local PVC Range Start [1]? 8
Local PVC Range End [1]? 8
Local X.25 DTE address [ ]? 108
Remote PVC Range Start [1]? 10
Remote PVC Range End [1]? 10
Remote X.25 DTE address [ ]? 301
```

```
XTP config>add pvc
Local PVC Range Start [1]? 10
Local PVC Range End [1]? 10
Local X.25 DTE address [ ]? 310
Remote PVC Range Start [1]? 8
Remote PVC Range End [1]? 8
Remote X.25 DTE address [ ]? 108
```

3. A PVC range can be defined through the PVC range start and PVC range end parameters. The same number of circuits must be defined in

## XTP Configuring Commands (Talk 6)

the local PVC range as in the remote PVC range. For example, if one circuit is defined in the local PVC range, one circuit must be defined in the remote PVC range.

4. The PVCs defined must fall within the range of 1 to 255.

**Note:** When you add PVCs to the router configuration, you also must configure the PVC in X.25. For details on configuring X.25 interfaces, refer to the *Software User's Guide*

## Change

Changes a peer router, remote DTE, or PVC from the XTP configuration.

### Syntax:

```
change                peer-router
                        remote-dte
                        pvc
```

### peer-router

Changes specific peer routers from the XTP configuration.

#### Example:

```
change peer-router
Router IP Address [0.0.0.0]?128.185.100.2
```

### remote-dte

Changes specific remote DTEs in the XTP configuration.

#### Example:

```
change remote-dte
DTE address [ ]?401
Peer router's internal IP Address [0.0.0.0]?128.185.100.2
Peer router's internal IP Address [0.0.0.0]?
```

**pvc** Changes PVC definitions for all PVCs in the range defined by the Local PVC Range Start parameter.

#### Example:

```
change pvc
Local PVC Range Start [1]?1
Local DTE address [ ]?301
```

## Delete

Deletes a local DTE, peer router, remote DTE, or PVC from the XTP configuration.

### Syntax:

```
delete                bi-cug
                        cug
                        local-dte
                        peer-router
                        remote-dte
                        pvc
```

**bi-cug** Deletes a bilateral closed user group number used by this interface.

#### Valid values:

## XTP Configuring Commands (Talk 6)

- Y** Deletes the current CUG.
- N** Does not delete the current CUG.
- ALL** Deletes all remaining CUGs.
- Q** Stops deleting any remaining CUGs.

### Example:

```
delete bi-cug
Delete Pref BI-CUG [Y]?
Delete BI-CUG (2) [Y]? N
Delete BI-CUG (3) [Y]? q
```

**cug** Deletes the closed user group numbers used by this interface. This command works similar to the **delete bi-cug** command.

### Example:

```
del cug
Delete Pref CUG [Y]?
Delete CUG (2) [Y]?
Delete CUG (3) [Y]? q
```

### local-dte

Deletes specific local interfaces from the XTP configuration.

### Example:

```
delete local-dte
Interface number [0]?1
DTE address [ ]?101
Record deleted
```

### peer-router

Deletes specific peer routers from the XTP configuration.

### Example:

```
delete peer-router
Router IP Address [0.0.0.0]?128.185.100.2
Record deleted
```

### remote-dte

Deletes specific remote DTEs from the XTP configuration.

### Example: delete remote-dte

```
DTE address [ ]?401
```

**pvc** Deletes PVC definitions for all PVCs in the range defined by the Local PVC Range Start parameter.

### Example:

```
delete pvc
Local PVC Range Start [1]?1
Local DTE address [ ]?301
Record deleted
```

## Enable

Activates the XTP forwarder.

**Syntax:** `enable-xtp`

**Example:** `enable-xtp`

## XTP Configuring Commands (Talk 6)

### Disable

Deactivates the XTP forwarder.

**Syntax:** disable-xtp

**Example:** `disable-xtp`

### Set

Sets the XTP Keepalive Timer.

**Syntax:** keep-alive-timer

**Example:**

```
set keep-alive-timer
```

Keepalive timer in seconds [10]?60

### List

Lists the interfaces, peer routers, remote DTEs, or PVCs.

**Syntax:**

```
list                all  
                   cugs  
                   keep-alive-timer  
                   local-dtes  
                   peer-routers  
                   remote-dtes  
                   pvc  
                   xtp-status
```

**all** Displays all the interfaces, peer routers, remote DTEs, and PVCs configured for XTP.

**Example:**

```
list all
```

```
STATUS: XTP-DISABLED
```

```
Local DTEs:
```

```
Interface      DTE Address  
  1             44444          Calling DTE address is optional  
                Pref CUG      : 7777  Others : 9999 0  
                Pref BI-CUG   : 0      Others :  
  
  4             33333          Calling DTE address is optional  
                Pref CUG      : 1      Others : 2 3 4 5  
                Pref BI-CUG   : 6      Others : 7 8 9 10
```

```
Peer Routers    Connection Timeout
```

```
Remote DTEs:  
  DTE Address    Peer Router(s)
```

```
PVCs:  
Local PVC      Local DTE      Remote PVC      Remote DTE  
LCN Range      Address        LCN Range      Address  
Pref CUG       : 114  Others : 314 478
```



## XTP Configuring Commands (Talk 6)

```
Pref BI-CUG : 1    Others : 1 1 1 1111
```

```
KEEP-ALIVE-TIMER: 10 seconds
```

**cugs** Lists the CUG and BI-CUG numbers defined for the XTP protocol.

### keep-alive-timer

Displays all the Keepalive time configured for XTP.

### local-dtes

Displays all the local DTEs configured for XTP.

#### Example:

```
list local-dtes
```

```
Local DTEs:
Interface      DTE Addr
  1             101 Calling DTE address is required
  2             201 Calling DTE address is required
```

### peer-routers

Displays all the peer routers configured for XTP.

#### Example:

```
list peer-routers
```

```
Peer Routers:
128.185.100.2
128.185.100.3
```

**pvcs** Displays all the PVCs configured for XTP.

#### Example-

```
list pvcs
```

```
PVCs:

Local PVC      Local DTE      Remote PVC      Remote DTE
LCN Range     Address        LCN Range       Address
  1 - 1         100           1 - 1           301
```

### remote-dtes

Displays all the remote DTEs configured for XTP.

#### Example:

```
list remote-dtes
```

```
Remote DTEs:
DTE Address    Peer Router
  301          128.185.100.2
  401          128.185.100.3
  402          128.185.100.3
  403          128.185.100.3
  404          128.185.100.3
```

### xtp-status

Displays the status of XTP indicating whether it is enabled or disabled.

#### Example:

```
list xtp-status
```

```
STATUS: XTP-ENABLED
```

---

## XTP Monitoring Commands

This section describes the XTP monitoring commands. These commands allow you to display the current active interfaces, peer routers, remote DTE, PVCs and SVCs. They also allow you to dynamically add or delete interfaces, DTEs, or peer routers.

To display the XTP> prompt, enter **protocol xtp** at the monitoring (+) prompt:

## XTP Monitoring Commands (Talk 5)

```
+protocol xtp
X.25 Transport Console
XTP>
```

Enter the XTP monitoring commands at the XTP> prompt.

Table 67. XTP Monitoring Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Dynamically adds local DTEs, remote DTEs, or peer routers
Delete	Dynamically deletes configurations for local DTEs, remote DTEs, or peer routers
List	Displays individual PVC or SVC statistics and general information
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Add

Adds an interface, peer router, or remote DTE to the XTP configuration.

#### Syntax:

```
add                _local-dtes
                    _peer-router
                    _remote-dtes
```

#### local-dtes

Adds a local interface to the XTP configuration.

##### Example:

```
add local-dtes
Interface number [0]?1
DTE address [ ]?101
```

#### peer-router

Adds a peer router to the XTP configuration.

##### Example:

```
add peer-router
Router's IP Address [0.0.0.0]?128.185.100.2
```

#### remote-dtes

Adds a remote DTE to the XTP configuration.

##### Example:

```
add remote-dtes
Peer router's IP Address [0.0.0.0]?128.185.100.2
DTE address [ ]?301
DTE address [ ]?
```

### Delete

Deletes a local DTE, peer router, or remote DTE from the router configuration.

#### Syntax:

```
delete            _local-dtes
                    _peer-router
                    _remote-dtes
```

### local-dtes

Deletes a local interface from the XTP configuration.

**Example:**

```
delete local-dtes

Interface Number [0]?1
DTE address [ ]?101
DTE address [ ]?
```

### peer-router

Deletes a peer router from the XTP configuration.

**Example: delete peer-router**

```
Router's IP Address [0.0.0.0]?123.185.100.2
```

### remote-dtes

Deletes a remote DTE from the XTP configuration.

**Example:**

```
delete remote-dtes

DTE address [ ]?401
DTE address [ ]?
```

## List

Displays the current active interfaces, peer routers, remote DTEs, PVCs, and SVCs.

**Syntax:**

```
list                                all
                                     xtp-status
                                     local-dtes
                                     peer-routers
                                     remote-dtes
                                     pvc
                                     pvc-detailed
                                     pvcs-all-detailed
                                     svcs
                                     svc-detailed
                                     svc-all-detailed
```

**all** Displays output of all list command options.

**Example:**

```
list all
```

```
STATUS: XTP-ENABLED
KEEP-ALIVE TIMER = 20 seconds
```

```
LIST OF LOCAL DTES
```

```
-----
Interface      Local
No             DTE
1              101    Calling DTE address is required
2              201    Calling DTE address is required
```

```
LIST OF PEER ROUTERS
```

```
-----
Router          CNN      Number      Received      Sent
```

## XTP Monitoring Commands (Talk 5)

	State	of Ckts	Pkts	Bytes	Pkts	Bytes
128.185.100.3	Active	15	60	1533	12	142
128.185.100.2	Active	12	63	1620	10	130

### LIST OF REMOTE DTES

Remote DTE	Router IP
404	128.185.100.3
403	128.185.100.3
402	128.185.100.3
401	128.185.100.3
301	128.185.100.2

### LIST OF PVCs

Index No	Int No	PVC State	Local LCN	Local DTE	Remote LCN	Remote DTE
1	1	Active		100		301

### LIST OF SVCS (list svcs)

Index No	Int No	Logical Channel	SVC State	Local DTE	Remote DTE	Peer Router
1	2	5	ACT	333333333333	444444444444	3.3.3.3

### SVC 1 IN DETAIL (list svc-detailed)

Int No	Log Chn	SVC State	Received Pkts	Received Bytes	Sent Pkts	Sent Bytes	Dropped Pkts	Dropped Bytes
2	5	ACT	2	116	2	106	0	0

### LIST OF SVCS (svcs-all-detailed)

Int No	Log Chn	SVC State	Received Pkts	Received Bytes	Sent Pkts	Sent Bytes	Dropped Pkts	Dropped Bytes
2	5	ACT	1	7	1	2	0	0

## xtp-status

Displays whether XTP is enabled/disabled, and the time specified for the Keepalive Timer.

### Example:

```
list xtp-status
```

```
STATUS: XTP-ENABLED
KEEP-ALIVE-TIMER = 20 seconds
```

## local-dtes

Displays all the interfaces configured for XTP.

### Example:

```
list local-dtes
```

### LIST OF LOCAL DTES

Interface No	Local DTE	
1	101	Calling DTE address is required
2	201	Calling DTE address is required

## peer-routers

Displays all the peer routers configured for XTP.

### Example:

```
list peer-routers
```

### LIST OF PEER ROUTERS

Router	CNN State	Number of Ckts	Received Pkts	Received Bytes	Sent Pkts	Sent Bytes
128.185.100.3	Active	15	60	1533	12	142
128.185.100.2	Active	12	63	1620	10	130

**remote-dtes**

Displays all the remote interfaces configured for XTP.

**Example:**

```
list remote-dtes

LIST OF REMOTE DTES
-----
Remote   Router
DTE      IP
404      128.185.100.3
403      128.185.100.3
402      128.185.100.3
401      128.185.100.3
301      128.185.100.2
```

**pvc**

Displays all the PVCs configured for XTP.

**Example:**

```
list pvcs

LIST OF PVCS
-----
Index    Int   PVC   Local   Local   Remote   Remote
No       No   State LCN     DET    LCN     DTE
1        1    Active 100     100    301     301
```

**pvc-detailed**

Displays detailed information for a specific PVC definition. For a listing of Index numbers, enter **list all** at the xtp> prompt.

**Example:**

```
list pvc-detailed

PVC Index Number [1]?1

PVC 1 IN DETAIL
-----
Int   PVC   Received   Sent   Dropped
No   State Pkts  Bytes Pkts  Bytes Pkts  Bytes
1    ACTIVE 55    3220 35    2350 15    1870
```

**pvc**

Displays detailed information for all PVC definitions.

**Example:**

```
list pvcs-all-detailed

LIST OF PVCS
-----
INT Local   PVC   Received   Sent   Dropped
No  LCN     State Pkts  Bytes Pkts  Bytes Pkts  Bytes
1   100     ACTIVE 55    3220 35    2350 15    1870
```

**svcs**

Displays all the SVCs definitions.

**Example:**

```
list svcs

LIST OF SVCS
-----
Index    Int LOG   SVC   Local   Remote   Peer
No       No Chan State LCN     DTE     Router
1        1    1    Active 200     401     3.3.3.3
2        1    1    Active 200     402     3.3.3.3
3        2    2    Active 200     403     3.3.3.3
4        2    2    Active 200     404     3.3.3.3
```

**svc-detailed**

Displays information for specific SVC definitions.

**Example:**

```
list svc-detailed

SVC Index Number [1]?1
SVC 1 IN DETAIL
-----
```

## XTP Monitoring Commands (Talk 5)

Int No	LOG Chan	SVC State	Received		Sent		Dropped	
			Pkts	Bytes	Pkts	Bytes	Pkts	Bytes
1		ACTIVE	75	4220	55	3350	20	870

### svcs-all-detailed

Displays information for all the SVC definitions.

#### Example:

```
list svcs-all-detailed
```

```
LIST OF SVCS
```

```
-----  
Index      Int Log   SVC      Received      Sent      Dropped  
No         No  Chn  State   Pkts  Bytes  Pkts  Bytes  Pkts  Bytes  
1          1   1    ACTIVE  4220   55    550   20    870  
2          1   1    ACTIVE  3220   40    2350  15    970  
3          2   2    ACTIVE  4003   50    3892  20    870  
4          2   2    ACTIVE  3967   58    4167  12    800
```

---

## X.25 Network Interface Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

X.25 network interface does not support the CONFIG (Talk 6) **delete interface** command.

### GWCON (Talk 5) Activate Interface

X.25 network interface does not support the GWCON (Talk 5) **activate interface** command.

### GWCON (Talk 5) Reset Interface

X.25 network interface does not support the GWCON (Talk 5) **reset interface** command.

---

## Chapter 41. Using Frame Relay Interfaces

This chapter describes how to use the Frame Relay (FR) interface and includes the following sections:

- “Frame Relay Overview”
- “Frame Relay Network Management” on page 506
- “Frame Relay Data Rates” on page 508
- “Circuit Congestion” on page 511
- “Bandwidth Reservation over Frame Relay” on page 515
- “Fragmentation Over a Frame Relay Interface” on page 515
- “Voice Forwarding Over Frame Relay” on page 516
- “Displaying the Frame Relay Configuration Prompt” on page 521
- “Frame Relay Basic Configuration Procedure” on page 522
- “Enabling Frame Relay PVC Management” on page 522
- “Enabling Frame Relay SVC Management” on page 523

---

### Frame Relay Overview

The FR protocol is a method of transmitting internetworking packets by combining the packet switching and port sharing of X.25 with the high speed and low delay of time division multiplexing (TDM) circuit switching. FR allows you to connect multiple LANs to a single high-speed (1.54 Mbps) WAN link with multiple point-to-point virtual circuits (VCs). FR offers the following features:

- *High throughput and low delay.* Utilizing the *core aspects* (error detection, addressing, and synchronization) of the Link Access Protocol, D-Channel (LAPD) datalink protocol, FR eliminates all network layer (Layer 3) processing. By using only the core aspects, FR reduces the delay of processing each frame.
- *Congestion detection.* Upon receiving Backward Explicit Congestion Notification (BECN) or a Forward Explicit Congestion Notification (FECN), the router initiates a controlled slowdown of traffic, thereby avoiding a complete FR network shutdown.

The router can also initiate a slowdown of traffic when it receives a Consolidated Link Layer Management (CLLM) congestion message. CLLM is an optional part of the FR standards that provides additional management information about the operation of the frame relay network to attaching DTEs.

- *Circuit access and control.* As the router dynamically learns about the availability of non-configured circuits (orphan circuits), you can control access to those new circuits.
- *Network management option.* As your network requires, the FR protocol can operate with or without a local network management interface.
- *Multiplexing protocols.* Using one VC to pass multiple protocols.
- *Data compression* that supports the FRF.9 standard. See “Using Data Compression” in *Using and Configuring Features* for details.
- *Data encryption* using a proprietary encryption scheme. Refer to “Using and Configuring Data Encryption” in *Using and Configuring Features* for details.

FR provides no error correction or retransmission function. To provide error-free end-to-end transmission of data, FR relies on the intelligence of the host devices.

### Frame Relay Network

The FR network consists of the FR backbone (consisting of FR switches provided by the FR carrier) providing the FR service. The router functions as the FR

## Using Frame Relay

connection device. The router encapsulates FR frames and routes them through the network based on a Data Link Connection Identifier (DLCI). The DLCI is the medium access control (MAC) address that identifies the PVC or SVC between the router and the FR destination device. For example, in Figure 38, router D receives packets from and sends packets to router B over DLCI 16 and router B receives packets from and sends packets to router D over DLCI 19. The FR provider is responsible for completing the circuit by connecting DLCI 19 attached to router B to DLCI 16 attached to router D. A similar relationship exists between router D and router A using DLCIs 17 and 18, respectively.

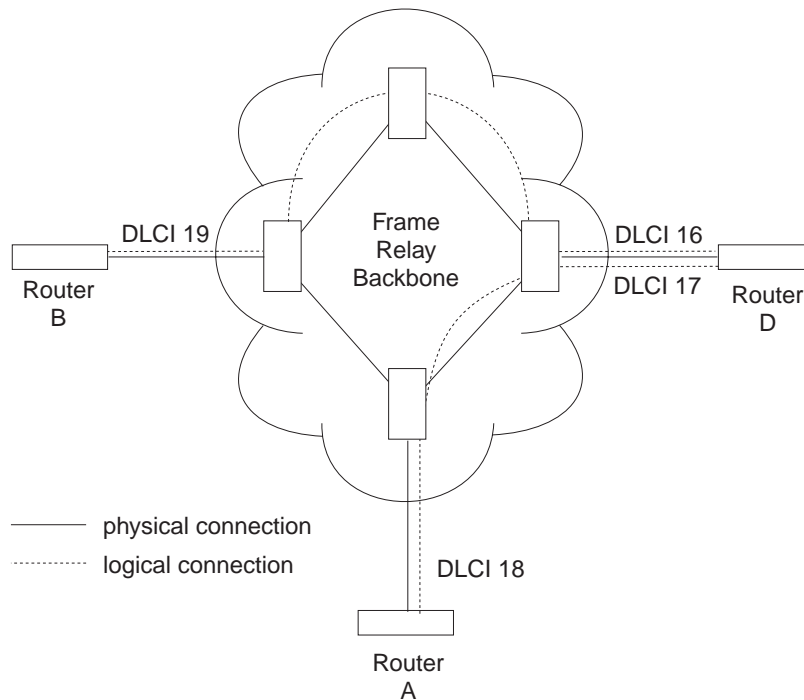


Figure 38. DLCIs in FR Network

A DLCI can have either local or global significance. Local DLCIs are significant at the point of entry to the network, but global DLCIs are significant throughout the network. To the user, however, the DLCI that the router uses to route a packet is the DLCI that the user associates with the frame's global or local destination. DLCIs are configured through the FR configuration process or learned through FR management.

FR PVCs are predefined connections used to route data through an FR network. The bandwidth allocated for a PVC within the network is a subscription option and must be allotted to the PVC whether or not the PVC uses it.

A FR network has the following characteristics:

- Transports frames transparently. The network can modify only the DLCI, congestion bits, and frame check sequence. High-Level Data Link Control (HDLC) flags and zero bit insertion provide frame delimiting, alignment, and transparency.
- Detects transmission, format, and operational errors (frames with an unknown DLCI).
- Preserves the ordering of frame transfer on individual VCs.



- Does not acknowledge or retransmit frames.

## Subinterfaces for Frame Relay

FR subinterfaces are logical interfaces that are associated with an FR interface. You must define the FR interface, known as the FR base interface, before you configure one or more FR subinterfaces. The FR subinterfaces are said to be associated with the FR base interface.

After you create an FR subinterface, you can configure circuits over it just as you would over any FR interface. Note, however, that certain interface characteristics, such as compression and encryption, can be enabled and disabled only on the base interface.

Using FR subinterfaces has three main advantages:

1. Allows you to have better control over interface-level broadcasts (for example, RIP) and interface-level filters.
2. Improves the usability of WAN reroute by not requiring the FR base interface to fail before backing up a single PVC. This is done by defining a PVC on a subinterface and making the subinterface the primary interface for a WAN reroute alternate.
3. Allows you to dynamically add PVCs and SVCs to an interface without resetting the base FR interface. To do this, define PVCs or SVCs on subinterfaces in Talk 6 and activate those subinterfaces in Talk 5.

The command to create an FR subinterface is **add dev fr**.

### Example:

```
Config>add dev fr
Enter the number of Frame Relay Subinterface interfaces [1]?
Adding device as interface 4
Base net for the Frame Relay Subinterface interface(s) [0]? 3
Use "net " command to configure specific Frame Relay Subinterface parameters
```

## Frame Relay Switched Virtual Circuits

FR Switched Virtual Circuits (SVCs) provide the ability to implement “cut-through” routing in an FR network, minimizing or eliminating intermediate router hops between DTEs. Network complexity can be simplified and the DTE may experience improved performance.

SVCs may replace PVCs to conserve network bandwidth, reducing bandwidth cost.

FR SVC standards are a subset of ISDN standards and provide many of the same advantages as ISDN with less complexity.

The following protocols are supported over FR SVCs:

- AppleTalk 2
- ARP
- Bridging
- DECnet IV
- DLSw
- IP/OSPF/RIP/BGP4
- IPX

SVCs cannot be required and cannot belong to a required group.

## Using Frame Relay

### Frame Relay Frame Handler

FR Frame Handler allows the 2216 to act like an FR switch. This function allows traffic to be forwarded between PVCs on FR interfaces without using the routing or bridging function. Its main purpose is to allow proprietary or unsupported routing protocols to be forwarded through the network device over FR PVCs. This can be done, for example, to connect a network device sending a proprietary protocol directly to a 2216 instead of to the FR network to save FR access costs. The proprietary traffic could then be forwarded over its own PVC through the FR network to the destination router, which could also be front-ended by a 2216. The 2216 can use different PVCs over the same FR interface to route and bridge traffic through the FR network to other destinations. Another example for the use of this function is to front-end a controller or router that does not support FR traffic shaping with a 2216 and to allow the 2216 to perform this function for it to reduce the number of frames that the FR network discards because of congestion.

As part of the frame handler function, the 2216 will support both explicit (BECN and FECN) and implicit (frame discards) congestion processing. If you enable CIR monitoring, it causes both the inbound and outbound CIR to be controlled. If either CIR or congestion monitoring are enabled, the configured outbound queue depth for the frame handler PVC will be enforced. Exceeding the CIR or the outbound queue limit will result in frames having BECN and FECN set in the appropriate direction and also in a frame discard condition.

If monitoring is not enabled, BECN or FECN are not set and frames will be forwarded over the interface as long as input buffers are available on the inbound interfaces. The 2216 now also supports the network side of the FR local management interface (LMI). This allows LMI to be used in back-to-back network device configurations. Network-side LMI is often used in frame handler configurations. However, this is not required. Also note that you can use the network side LMI without using the frame handler function in configurations where LMI is useful in back-to-back router configurations.

FH and voice forwarding cannot be used on the same circuit.

Figure 39 on page 501 shows a typical FH configuration. On interface 1, PVCs 16 and 18 are defined as frame handler along with PVC 19 on interface 2 and PVC 20 on interface 3. All traffic received on these PVCs will be directly routed to their partner PVCs. Interface 1 is also shown supporting a DTE PVC. Data received over this PVC will be given to the appropriate routing function to be forwarded over any other interface in the network device.

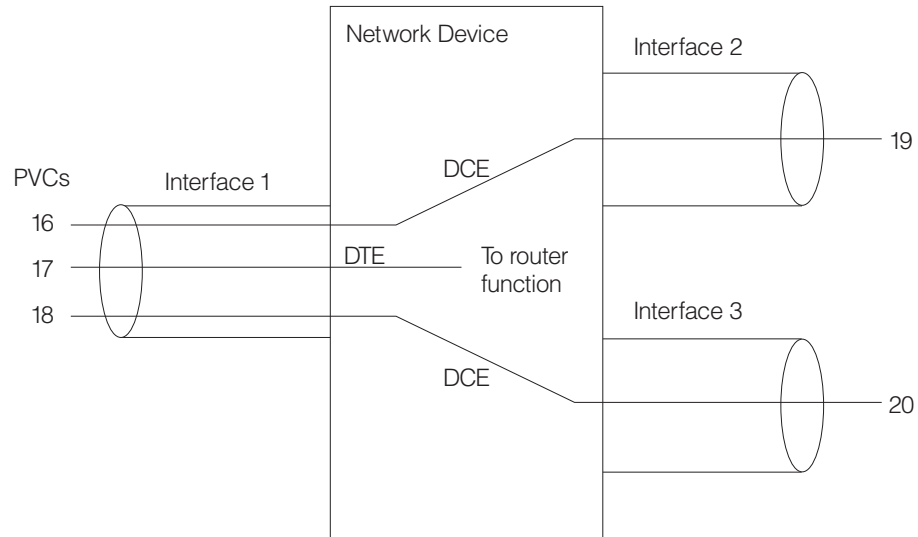


Figure 39. DTE and DCE Circuit Multiplexing

## Frame Relay Interface Initialization

Local Management Interface (LMI) is used to determine the status of PVCs on an FR interface. If an LMI is enabled, the FR interface is active when a successful exchange of LMI frames occurs between this router and the adjacent FR node; however, no data can be received from or transmitted to another router until an LMI status message indicates that the PVC status for the DLCI to the other router is active. Also, there are instances where the FR interface state is tied to PVC states and the interface does not come up even if LMI or Q.922 exchanges are successfully occurring (for additional information, see “Configuring PVC States to Affect the Frame Relay Interface State” on page 503).

If LMI is not enabled and SVCs are enabled, the FR interface is active when a successful exchange of Q.922 frames occurs between the router and the adjacent device. All PVCs are considered active at this point. However, SVCs are active only after a successful Q.933 activation exchange.

PVC status appears for all PVCs as either active or inactive. An active PVC has a completed connection to an end system. An inactive PVC does not have a completed connection to an end system because either an end system or an FR switch is off-line.

For example, in Figure 40 on page 502 router B has a configured PVC to router D. Router B is successfully interacting with FR management through FR switch B. Because either another FR switch is down or the end system is down, the end-to-end PVC connection is not established. Router B receives an inactive status for that PVC.

## Using Frame Relay

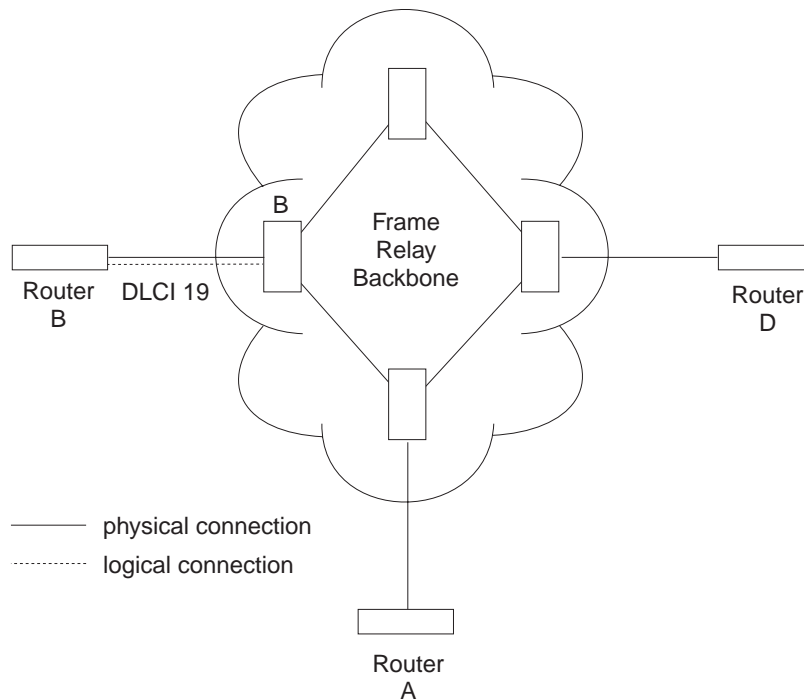


Figure 40. DLCIs in Frame Relay Network

The DSU connections must be configured to drop Data Set Ready (DSR), Clear To Send (CTS), or Data Carrier Detect (DCD) if the network connection is lost.

## Orphan Circuits

An orphan permanent virtual circuit is any PVC that is not configured for your router but is learned indirectly through the local management interface (LMI) connection with the frame relay provider. For example, Figure 41 on page 503 assumes that router B has a configured PVC to router D, but none to router A. A circuit between routers A and B can be attained without configuring Permanent Virtual Circuits (PVCs) in the router. The FR provider configures a circuit using Data Link Connection Identifiers (DLCIs) between the ports where router A and router B are connected. Routers A and B, when communicating over the LMI, request status and in return get a message indicating the presence of Data Link Connection Identifiers (DLCIs). PVCs learned in this manner are called *orphan circuits*. Router B would then learn about the PVC to router A from LMI messages and classify it as an orphan.

Orphan PVCs are treated the same as configured circuits except that you may enable or disable their use with the **enable orphan-circuit** and **disable orphan-circuit** commands.

**Note:** All orphan PVCs will be used as DTE, not FH, circuits. Orphan PVCs cannot be used for voice forwarding or APPN®.

By disabling orphan circuits, you add a measure of security to your network by preventing any unauthorized entry into your network from a non-configured circuit. By enabling orphan circuits, you allow the router to forward packets over circuits you did not configure. Packets that would normally be dropped are now forwarded.

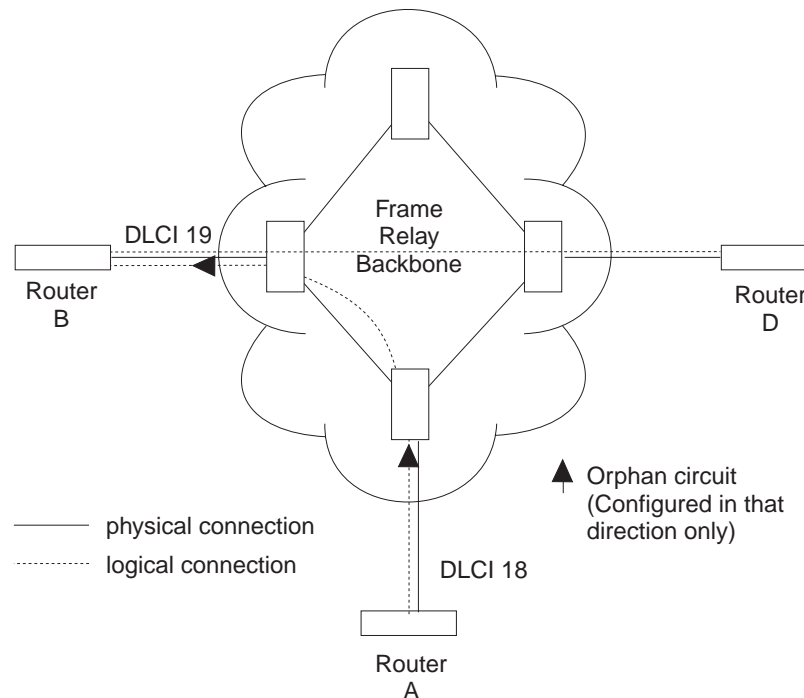


Figure 41. Orphan Circuit

An orphan switched virtual circuit is an SVC that is not configured for your router but is created when a call-in is received for it. This is similar to Figure 41. However, Q.933 messages are used instead of LMI to generate the circuit and associate the appropriate parameters with it. Orphan SVCs are treated the same as configured SVCs except that you may enable or disable their use with the call-in option of the **enable switched-virtual-circuit** command.

## Configuring PVC States to Affect the Frame Relay Interface State

You can control the operation of your FR interface by doing one of the following:

- Enabling the *No-PVC* feature
- Configuring *required PVCs*
- Configuring *required PVC groups*

By enabling the FR *No-PVC* feature, the FR interface becomes inactive if there are no active PVCs on the interface. If at least one PVC is active, the FR interface becomes active when a successful LMI exchange occurs between the router and the FR switch.

You can configure a PVC as a *required PVC*. If a PVC is required but not in a group, the FR interface becomes inactive when the PVC becomes inactive. When the PVC becomes active, the interface is activated following a successful exchange of LMI frames between the router and the FR switch.

If multiple PVCs are required and are not in a PVC group, the interface is not activated until all required PVCs are active.

If a required PVC belongs to a PVC group, the FR interface becomes inactive when all PVCs in the PVC group are inactive. If at least one PVC in the group is active, the interface becomes active following a successful exchange of LMI frames

## Using Frame Relay

between the router and the FR switch. If there are multiple PVC groups, the interface does not become active until at least one PVC *in each group* is active.

A *required PVC group* is a group of circuits associated by name, where *name* is the name of the required PVC group.

These features can be used with WAN Reroute so that an alternate link can be brought up if all PVCs, required PVCs, or a group of PVCs become inactive on the primary FR link.

## Point-to-Point Interface Option

For both base FR interfaces and FR subinterfaces, you can enable point-to-point. This option indicates whether the interface is point-to-point from the point of view of IP. If you configure an FR interface as point-to-point, unnumbered IP can run over the interface.

## Frame Relay Frame

An FR frame consists of a fixed size address field with variable sized encapsulated user data. Figure 42 illustrates an FR frame format.

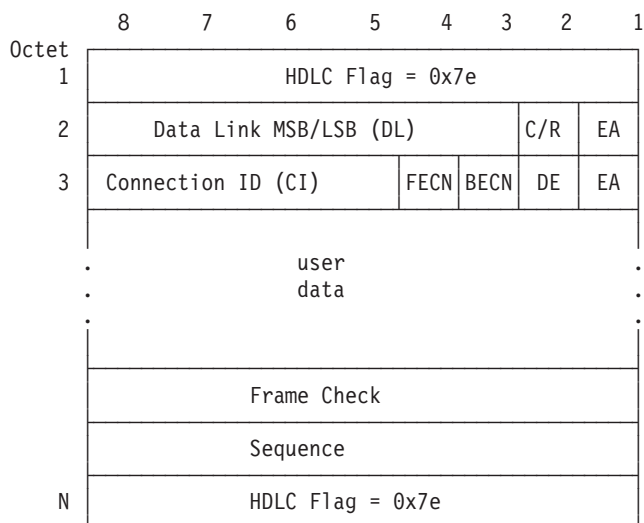


Figure 42. Frame-Relay Frame Format

### HDLC Flags

Located in the first and last octet, these flags indicate the beginning and end of the frame.

### Data Link Connection Identifier (DLCI)

This 10-bit routing ID resides in bits 3 to 8 of octet 2 and bits 5 to 8 of octet 3. The DLCI is the MAC address of the circuit. The DLCI allows the user and network management to identify the frame as being from a particular PVC. The DLCI enables multiplexing of several PVCs over one physical link.

### Command/Response (C/R)

This field's use is not defined within the FR standards and the field is passed transparently across the network.

### Extended Address

This version of FR does not support extended addressing.

### Forward Explicit Congestion Notification (FECN)

The FR backbone network sets this bit to 1 to notify the user receiving the frame that congestion is occurring for the PVC in the direction the frame is being sent. You can configure the device to slow down data transmission in the direction from which it receives a FECN using the **enable throttle-transmit-on-fecn** command. You can also set the BECN bit in data frames sent to the originator of the FECN using the **enable notify-fecn-source** command.

APPN High Performance Routing (HPR) uses detection of this bit set to allow Rapid Transport Protocol's adaptive rate-based flow and congestion control algorithm to adjust the data send rate. This algorithm prevents traffic bursts and congestion, maintaining a high level of throughput.

### Backward Explicit Congestion Notification (BECN)

The FR backbone network sets this bit to 1 to notify the user that the frames sent by this router for this PVC have encountered congestion. The router then initiates a *throttle down* to a rate equal to or less than the user-defined CIR when CIR or congestion monitoring are enabled. The CIR for a PVC is supplied by the FR service provider and is configured using the **add permanent-virtual-circuit** command.

### Discard Eligibility (DE)

The FR network may discard transmitted data exceeding CIR on a PVC. The DE bit can be set by the router to indicate that some traffic should be considered discard eligible. If appropriate, the FR network will discard frames marked as discard eligible which may allow frames that are not marked discard eligible to pass through the network. To identify traffic that is discard eligible:

1. Configure BRS on the FR interface and any FR circuits that has traffic that you are making discard eligible.
2. Assign a protocol or filter to a BRS traffic class using the **assign** command. You specify whether the DE bit should be set on for this protocol or filter traffic.

### User Data

This field contains the protocol packet being transmitted. This field can contain a maximum of 8188 octets; however, the frame check sequence (FCS) can effectively detect errors only on a maximum of 4096 octets of data. The protocol data is preceded by an FR encapsulation header as defined in RFC 1490 and RFC 2427.

### Frame Check Sequence

This field is the standard 16-bit cyclic redundancy check (CRC) that HDLC and LAPD frames use. This field detects bit errors occurring in the bits of the frame between the opening flag and FCS.

**Note:** Note: With the HSSI adapter there is an optional 32 bit Frame Check Sequence (FCS).

**Note:** You can configure the use of a 32-bit CRC for an FR interface on a HSSI adapter.

## Frame Forwarding over the Frame Relay Network

When the FR protocol receives a packet for encapsulation, it compares the packet's network address to the entries in the address resolution protocol (ARP) cache. If the ARP cache contains the DLCI number that matches the network address, the

## Using Frame Relay

FR protocol encapsulates that packet into a frame and transmits the frame over its specified local DLCI. If the ARP cache does not contain a match, the FR protocol sends out an ARP request over all configured PVCs on the interface. When the appropriate end-point responds with an ARP response, the FR protocol adds its local DLCI that received the ARP response to the ARP cache. Subsequent data packets directed to the same network address are then encapsulated into a frame and sent out over its local DLCI.

## Protocol Addresses

Protocol addresses can be either mapped statically to FR network PVC addresses or SVCs using locally configured names or discovered dynamically through Inverse ARP or ARP. (For more information on ARP and Inverse ARP, see the *Protocol Configuration and Monitoring Reference*.) Either method is protocol-dependent as illustrated in Table 68.

**Note:** Static protocol addresses are also referred to as static ARP entries. A static ARP entry is added to the configuration with the **add protocol-address** command.

Table 68. Protocol Address Mapping

Protocol Type	ARP and Inverse ARP Usage	Static Mapping	VC Configured at Protocol Configuration
AP2	Yes	Yes	No
IP	Yes	Yes	No
IPX	Yes	Yes	No
Banyan VINES**	No	No	No
DNA IV	Yes	Yes	No
OSI*, **	No	No	Yes

\* You must configure OSI at the protocol level to map the protocol address to the FR PVC.  
\*\* Not supported using SVCs.

## Multicast Emulation and Protocol Broadcast

Multicast emulation is an optional feature that allows protocols requiring multicast such as ARP to function properly over the FR interface. With multicast emulation, a multicast frame is transmitted on each active PVC. By using the **enable** and **disable multicast** commands, you can turn this feature on or off. Protocols that utilize multicast are AP2, ARP, Banyan VINES, DNA4, IP, and IPX.

Protocol broadcast is another optional feature that allows the IP RIP protocol to function properly over the FR interface. By using the **enable protocol-broadcast** and **disable protocol-broadcast** commands, you can turn this feature on or off.

For protocols that support ARP/InARP over FR, FR will only multicast a protocols packets over a circuit if a protocol address was either learned or configured for that circuit.

Multicast can also be enabled or disabled for an individual SVC. Use the multicast option on **add switched-virtual-circuit**.

---

## Frame Relay Network Management

The supplier of the FR network backbone provides FR network management. It is management's responsibility to provide FR end-stations (routers) with status and configuration information concerning PVCs available at the interface.



For PVCs, the FR protocol supports the ANSI T1.617 Annex D, ITU-T Q.933 Annex A (also referred to as CCITT Q.933 Annex A), and the Interim Local Management Interface (LMI) management entities. You can turn these entities on or off using the **enable** and **disable** LMI configuration commands. Once LMI is enabled, use the **set** command to select the LMI standard to be used and the LMI network type. The LMI standard, ANSI, CCITT, or REV1, must be compatible with the adjacent FR node. The LMI network type determines whether FR only requests status of the adjacent node, only provides status to the adjacent node, or does both simultaneously. The LMI network type must also be compatible with the adjacent FR node. Specifically, FR LMI provides the following information:

- Notification of additional PVCs (orphans) and whether they are active or inactive, or notification of any PVC deletions.
- Notification of the availability of a configured PVC. The availability of a PVC is indirectly related to the successful participation of the PVC end-point in the *heartbeat polling* process, which is detailed in “Link Integrity Verification Report” on page 508.
- Verification of the integrity of the physical link between the end-station and network by using a *keep alive* sequence number interchange.

Although the FR interface supports PVC network management, it is not necessary for management to run on the FR backbone for the interface to operate over the FR backbone. For example, you may want to disable management for back-to-back configurations; however, this is not always necessary since FR provides both the user and network sides of the LMI management protocol.

For SVCs, the FR protocol supports FRF 4 (Frame Relay Forum Implementation Agreement 4). This includes an implementation of ANSI Q.922 and a subset of ANSI Q.933. Q.922 provides verification of the integrity of the physical link between the router and the network. Q.933 provides the means for establishing and disconnecting SVCs across the network. Q.922 and Q.933 are always enabled when SVCs are used.

## Management Status Reporting

Upon request, FR LMI provides two types of status reports, a full status report and a link integrity verification report. A full status report provides information about all PVCs the interface knows about. A link integrity verification report verifies the connection between a specific end station and a network switch. All status inquiries and responses are sent over DLCI 0 for ANSI T1.617 Annex D and ITU-T Q.933 Annex A, or DLCI 1023 for interim LMI management.

## Full Status Report

When the FR interface requires a full status report, the router’s FR protocol sends a status enquiry message to the FR network backbone requesting a full status report. A status enquiry message is a request for the status of all PVCs on the interface. Upon receiving this request, FR management must respond with a full status report consisting of the link integrity verification element and a PVC status information element for each PVC (see “Link Integrity Verification Report” on page 508).

The PVC status information element contains the following information: the local DLCI number for the particular PVC, the state of the PVC (active or inactive), and whether the PVC is new or an existing PVC that management already knows about.

**Note:** The number of PVCs supplied at the FR interface is restricted by the network frame size and the amount of individual PVC information elements

## Using Frame Relay

that can fit into a full status report. For example, 202 is the maximum number of PVCs for a network with a 1-K frame size.

## Link Integrity Verification Report

The link integrity verification report, sometimes referred to as *heartbeat polling*, contains the link integrity verification element. This element is where the exchange of the send and receive sequence numbers takes place. By exchanging sequence numbers, management and the end station can evaluate the integrity of the synchronous link. The send sequence number is the current send sequence number of the message originator. The receiver looks at this number and compares it to the last send sequence number to verify that this number is incrementally correct. The receive sequence number is the last send sequence number that the originator sent out over the interface. It is the receiver's responsibility to place a copy of the send sequence number into the receive sequence number field. This way the originator can ensure that the receiver receives and interprets the frames correctly.

When an end-station fails to participate in this polling process, all remote end-stations with logically attached PVCs are notified through management's full status report mechanism that the PVC is inactive.

## Consolidated Link Layer Management (CLLM)

CLLM is an optional FR management function that is not widely supported by the industry but it has been adopted by some FR switch manufacturers. CLLM provides some of the same management information provided by LMI, in particular, outage notification. CLLM's main use is to provide asynchronous congestion notification of PVCs to attaching devices. A single CLLM message may indicate outage or congestion for multiple PVCs. The FR protocol supports the following standards for CLLM: ANSI T1.618, ITU-T (CCITT) Q.922 Annex A, and ITU-T (CCITT) X.36 Annex C.

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## Frame Relay Data Rates

This section introduces data rates for FR permanent virtual circuits (PVCs) and switched virtual circuits (SVCs).

### Committed Information Rate (CIR)

The CIR is the data rate that the network commits to support for the VC under normal, uncongested conditions. Any VC that is configured or is learned is provided a CIR (by the FR network backbone provider). The CIR is a portion of the total bandwidth of the physical link of either 0, or between 300 bps and 2 Mbps\* reserved for the VC. A value of 64 kbps for a single DS0 channel is most common.

**\*Note:** The maximum CIR value for an FR interface on a HSSI adapter is 52 Mbps.

You define the CIR with the **add permanent-virtual-circuit**, **change permanent-virtual-circuit**, **add frame-handler**, **change frame-handler**, **add switched-virtual-circuit**, or **change switched-virtual-circuit** configuration command. You can also dynamically change the CIR with the **set circuit** console command. You can also set the default CIR for all Frame Relay circuits on this interface using the **set CIR-defaults** command.

Some FR switches allow a value of 0 to be configured for CIR. When CIR is equal to 0, little or no bandwidth is reserved in the FR network backbone for the VC, and the VC's traffic uses non-reserved bandwidth.

### Orphan Permanent Virtual Circuit CIR

The router assigns a CIR to orphan circuits based on the CIR defaults configured at the interface level. If you are relying on the orphan circuit to route important data and the CIR, Bc, and Be values from the network provider are different from the values configured at the interface level, it is recommended that you define a PVC instead of an orphan circuit. Doing this, you can assign a CIR that the network commits to support.

### Committed Burst (Bc) Size

The *committed burst (Bc) size* is the maximum amount of data (in bits) that the network commits to deliver during a *calculated time (Tc) interval*. The Tc is equal to the Bc divided by the CIR ( $Tc = Bc / CIR$ ). If you configure 0 for CIR, FR uses a value of 1 second for Tc.

For example, if you set a VC's CIR to 9600 bps and the committed burst size to 14 400 bits, the time period is 1.5 sec. ( $14\ 400 \text{ bits} / 9600 \text{ bps} = 1.5 \text{ sec}$ ). This means that the VC is allowed to transmit a maximum of 14 400 bits in 1.5 seconds.

**Note:** The minimum Tc supported by FR is 0.03 of a second.

This parameter is important because of the relationship between the committed burst size and the maximum frame size. If the maximum frame size in bits is greater than the committed burst size, the network may discard frames whose size exceeds the committed burst size. Therefore, the committed burst size should be greater than or equal to the maximum frame size. It should also equal the burst size set up with the network provider.

Use the **add permanent-virtual-circuit**, **change permanent-virtual-circuit**, **add frame-handler**, **change frame-handler**, **add switched-virtual-circuit** or **change switched-virtual-circuit** configuration commands to set the committed burst size. The **set circuit** console command can be used to dynamically change the committed burst size. You can also set the default committed burst size for all FR circuits on this interface using the **set CIR-defaults** command.

The device assigns orphan circuits a committed burst size based on the default you set with the **set CIR-defaults** command. If you configure 0 for CIR, then the committed burst (Bc) size also equals 0.

### Excess Burst (Be) Size

The *excess burst (Be) size* is the maximum amount of uncommitted data the router can transmit on a PVC in excess of the Bc during the Tc ( $Tc = Bc / CIR$ ) when CIR and Bc are nonzero. When CIR = 0, FR uses a value of 1 second for Tc.

The network delivers this excess data with a lower probability of success than committed burst size data. Set the Be to a value greater than zero only if you are willing to accept the risk of discarded data and its effect on higher-layer protocol performance. The Be should equal the value set up with the network provider.

Use the **add permanent-virtual-circuit**, **change permanent-virtual-circuit**, **add frame-handler**, **change frame-handler**, **add switched-virtual-circuit** or **change**

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**switched-virtual-circuit** commands during frame-relay configuration to set the excess burst size. You can also use the **set circuit** console command to dynamically change the excess burst size. Orphan circuits will receive a default excess burst size equal to the value set in the **set CIR-defaults** command. If you configure 0 for CIR, then you must configure a nonzero value for the excess burst (Be) size. You can also set the default excess burst size for all FR circuits on this interface using the **set CIR-defaults** command.

## Line Speed

The *line speed* is the interface's line speed.

The FR interface's line speed is configured using the **set line-speed** configuration command. The line speed must be configured when internal clocking is used. However, it is recommended that you configure a line speed for external clocking since the router uses the line speed as the maximum information rate when congestion monitoring is enabled. Also some of the protocols use an interface's configured line speed when calculating a route's cost.

The line speed is not configurable on an FR dial circuit interface. If the dial circuit is mapped to an ISDN base interface, 64 kbps is used as the line speed.

For dial circuits using Channelized T1/E1 as the base net, the line speed is 64 kbps times the number of timeslots assigned or 56 kbps if you set the bandwidth of the Channelized circuit to 56 kbps. For example, if you set the number of timeslots for a Channelized circuit to 3, the line speed is 192 kbps (3 \* 64 kbps).

If the dial circuit is mapped to a V.25 bis base interface, the line speed of the V.25 bis interface is used for the FR dial circuit.

## Minimum Information Rate

The *minimum information rate (IR)* is the minimum data rate for a VC that the router throttles down to when it is notified of congestion. You set the minimum IR as a percentage of CIR using the **set ir-adjustment** configuration command. It can be dynamically changed using the **set ir-adjustment** console command. If you configure CIR equal to 0, the minimum IR is 1500 bps.

## Maximum Information Rate

The *maximum information rate* is the maximum data rate at which the router transmits for a VC. If the CIR monitoring feature is enabled and CIR and Bc are nonzero, the maximum information rate is calculated using CIR, Bc, and Be as follows:

$$( Bc + Be ) \text{ per } Tc \text{ interval}$$

If the CIR monitoring feature is enabled and CIR and Bc are configured equal to 0, the maximum information rate is equal to the excess burst size (Be) per second.

If the CIR monitoring feature is not enabled the maximum information rate is equal to the line speed.

## Variable Information Rate

The *variable information rate (VIR)* ranges from the configured minimum IR to the calculated maximum IR when the CIR monitoring or congestion monitoring features are enabled. The VIR is gradually decreased down to the minimum information rate

when the router is notified of congestion on a circuit and is gradually increased to the maximum information rate when the router stops receiving congestion notifications. Using the **set ir-adjustment** configuration command, you configure the percentage of the information rate by which the VIR should decrease when the router is notified of congestion. You also use this command to configure the percentage of the information rate by which the VIR should be gradually increased when the congestion ends.

To avoid impulse loading of the network, the router initially sets the VIR to CIR when the VC becomes active. If you configure 0 for CIR, VIR is initially set to excess burst (Be) times the MIR adjustment percentage. For example, if Be is set to 64 000 and the MIR adjustment percentage is set to 25%, then the initial VIR would be equal to 16 000 bps.

The VIR can actually exceed the maximum value in one case. If the length of a frame in bits is greater than the maximum IR, FR transmits the frame anyway.

**Note:** Frame Handler (FH) circuits do not use a VIR. The send rate for an FH circuit remains at the maximum-sent rate confirmed for the circuit.

---

## Circuit Congestion

**Note:** FH circuits, like other circuits, use FR frames to determine when congestion occurs and to notify the routers. However, they have their own methods for monitoring and handling circuit congestion. See “Frame Handler Circuit Congestion” on page 514 for more information.

Circuit congestion occurs for one of the following reasons:

- The sender is transmitting faster than the allowable throughput
- The receiver is too slow when processing the frames
- An intermediate backbone link is congested, resulting in the sender transmitting faster than the available throughput allows.

If circuit congestion occurs, the network must drop packets, or shut down, or both.

In response to circuit congestion, the router implements a *throttle down*, which is a step-wise slowing of packet transmission to the configured minimum IR. Throttle down occurs during the following conditions:

- Circuit congestion is occurring.
- The router is the sender of frames.
- CIR monitoring or congestion monitoring is enabled.

The following topics discuss monitoring FR data rates and circuit congestion.

## CIR Monitoring

CIR monitoring is an optional FR feature that you can set for each interface to prevent the router from creating congestion conditions in the FR network. CIR monitoring allows the VIR for a VC to range between the configured minimum and maximum IR.

CIR monitoring is configured with the **enable cir-monitor** configuration command and is disabled by default. CIR monitoring, when enabled, overrides congestion monitoring. You can also dynamically enable and disable CIR monitoring using the **enable cir-monitor** and **disable cir-monitor** console commands.

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### Congestion Monitoring

Congestion monitoring is an optional feature, set per interface, that allows the VIR of VCs to vary in response to network congestion. The VIR assumes values between the minimum IR and a maximum IR of the line speed. Congestion monitoring is enabled by default. It can be disabled with the **disable congestion-monitor** configuration command and re-enabled with the **enable congestion-monitor** command. You can also dynamically enable and disable congestion monitoring using the **enable congestion-monitor** and **disable congestion-monitor** console commands.

CIR monitoring, if enabled, overrides congestion monitoring. If both CIR monitoring and congestion monitoring are disabled, the VIR for each VC on the interface is set to the line speed and does not decrease in response to network congestion.

**Note:** Even with compression enabled, the device uses the uncompressed size of frames to determine if the VIR is being exceeded.

### Congestion Notification and Avoidance

If congestion occurs, the FR backbone network is responsible for notifying the sender and receiver by sending out a FECN or a BECN signal. FECN and BECN are bits that are set in a frame to notify the DTEs at each end of a VC that congestion is occurring. FECN indicates that congestion is occurring in the same direction from which the frame was received; the sender is causing the congestion. BECN indicates that the frames sent by this DTE are causing network congestion.

Optionally, the network can use CLLM messages to convey congestion information for PVCs. CLLM messages are sent only to the congestion source and should be treated similarly to BECN messages by the DTE.

The example in Figure 43 on page 513 shows a congestion condition at switch B when frames are sent from router X to router Y. The FR backbone network notifies router X that frames it sends are encountering congestion by setting the BECN bit in frames sent to router X. The FR backbone network also notifies router Y that frames it receives encountered congestion by setting the FECN bit.

If the router receives a frame containing BECN, it is the router's responsibility to throttle down the VC's variable information rate (VIR) if either CIR monitoring or congestion monitoring is enabled. The router does this gradually as it receives consecutive frames with BECN until either the minimum IR is reached or a frame without BECN arrives. FR switches often set BECN in multiple frames after reaching a congestion threshold. In order for FR to avoid overreacting to network congestion when the network is setting multiple frames with BECN, FR will decrease a VC's VIR at most once every second. This allows the VIR to decrease gradually. As the router receives consecutive frames without BECN, the VIR gradually rises to the maximum IR.

Depending on the operation of the FR network, it may be necessary for the device to throttle down the VC's VIR when the device receives a FECN to minimize the overall amount of traffic being offered to the network as quickly as possible. Reducing the overall load on the network reduces the number of packets discarded for all VCs to relieve congestion. Enabling the **throttle-transmit-on-fecn** parameter, along with either the CIR or congestion monitoring options, causes the device to treat a FECN like a BECN thus reducing overall FR network congestion when any congestion notification is received. Use the **throttle-transmit-on-fecn** parameter only in FR networks whose queuing methods do not provide dedicated buffers for both



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input and output. If the **throttle-transmit-on-fecn** is enabled, FR will decrease a VC's VIR at most once every second for each BECN or FECN received.

Some FR network switches set FECN to indicate congestion but do not set BECN. To provide congestion notification to the source of the congestion, enable the **notify-fecn-source** parameter allowing the device to set BECN in frames that it transmits over a VC on which it has received a FECN. This action provides a signal to the device that is causing the network congestion to throttle down its VC's VIR.

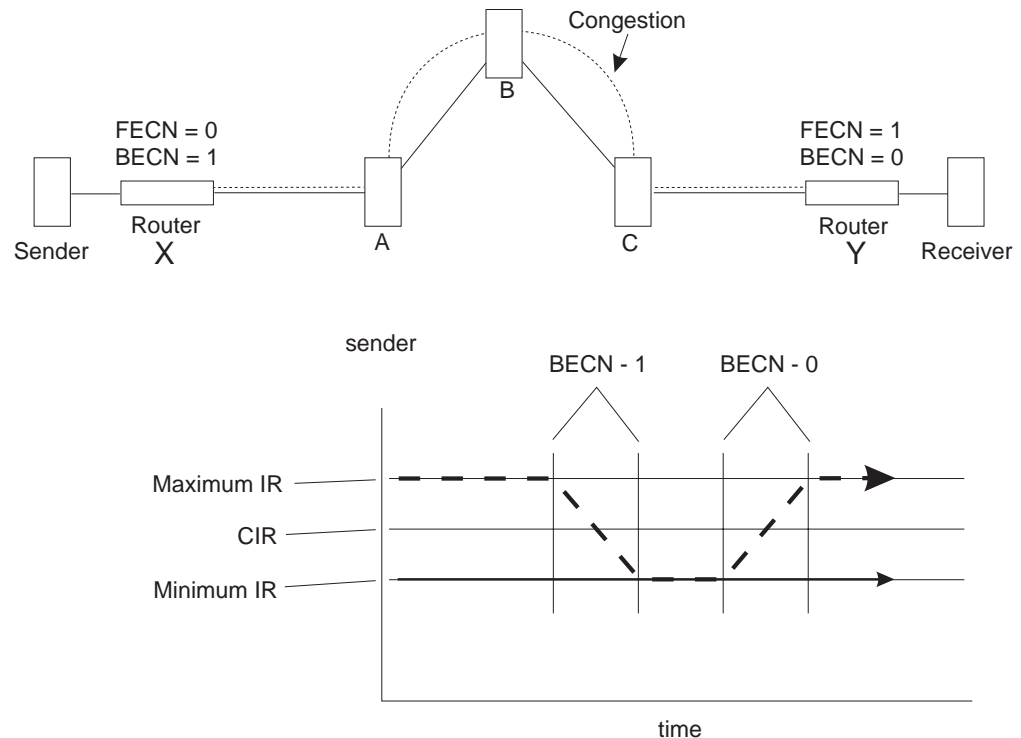


Figure 43. Congestion Notification and Throttle Down

**Note:** If multiple DLCIs are configured between two end-stations when congestion occurs, it is possible that a second DLCI may be used to transmit data at a higher throughput until the congestion condition on the first DLCI is corrected.

Similarly, if the network provider supports CLLM, you can configure FR to *throttle down* its transmit rate for PVCs contained in a CLLM message. CLLM messages contain a cause code that indicates the type and severity of the problem being reported. The device reacts differently depending on the cause code and the CIR configured for each PVC contained in the CLLM message. When the device receives a CLLM message that indicates:

- A short-term condition, and the configured CIR for the PVC is nonzero, the FR protocol will throttle the transmit rate for the affected PVCs by the configured IR decrement percentage.
- A long-term condition, the FR protocol will set the transmit rate for the affected PVCs to the calculated minimum information rate.
- Facility or equipment failure or maintenance action, or if the CIR was configured as zero, the FR protocol will continue to transmit any queued data for the affected PVCs but will not accept any more outgoing packets from the upper layer protocols until the congestion condition is cleared.

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Once a CLLM message for a PVC has been received, if the device does not receive any CLLM messages or BECNs within the  $T_y$  timer period or if a frame without a BECN is received, the device will consider the congestion condition cleared and gradually return the PVC to its configured transmission rates. If you are using CLLM to control congestion, you must not configure DLCI 1007 for any other use.

---

## Frame Handler Circuit Congestion

Acting as part of the FR switching network, Frame Handler (FH) circuits can perform congestion control and monitoring in a similar way to DTE circuits. When either CIR or congestion monitoring are enabled on an interface on which an FH circuit is defined, the FH circuit and its partner circuit work together to control the rate of data through the router and to notify the attaching DTE circuits when congestion occurs. It is then the responsibility of the DTE to react to the congestion indications set by the FH circuits.

Note that unlike DTE circuits, FH circuits do not use a variable information rate. The send rate for an FH circuit is set to its configured value and never changes. Again, it is up to the DTE to change its send rate in reaction to congestion. The router will preserve the BECN/FECN/DE bit settings in frames that it is forwarding if the bit was already set by either the DTE or by another switch or router in the path; that is, FH will not turn the bits off, but it may turn them on.

Congestion processing for the FH PVCs can operate in one of three modes: CIR monitoring, congestion monitoring, and no monitoring. The type of monitoring used for a given FH PVC is determined by what is enabled on the outbound interface. For example, if you want to enable monitoring of the receive information rate for FH PVCs, you must enable CIR monitoring on the outbound interface of the circuit. Although this seems somewhat confusing, it is most likely that the interfaces on which the partner FH PVCs are defined will both be configured for the same type of monitoring.

## CIR Monitoring

When you enable CIR monitoring, both the transmit and receive data rates will be monitored to ensure that they are kept with the configured values. A  $T_c$  of one second will be used on the receive side regardless of the CIR and  $B_c$  values. When the FH is processing a received frame, BECN will be set in the first frame queued for transmit in the opposite direction (if one exists) and FECN will be set in the first frame queued for transmit in the same direction (if one exists) if any one of the following conditions is true:

- Receiving the next frame exceeds the receive information rate. Using a  $T_c$  of one second, the receive information rate is calculated by  $(B_c + B_e) / (B_c / CIR)$ .
- The input device is low on receive buffers and receiving the next frame exceeds the fair value for the interface.
- Receiving the next frame exceeds 80% of the configured maximum queue depth.

CIR monitoring is configured with the **enable cir-monitor** configuration command and is disabled by default. A frame will be discarded if the receive CIR is being exceeded by 10% or the maximum queue depth is exceeded. If a frame is to be discarded, then FR will discard the first frame that has the DE bit set and should be forwarded. If no frame with the DE bit is found, then the received frame will be discarded instead of being forwarded. CIR monitoring, when enabled, overrides congestion monitoring. You can also dynamically enable and disable CIR monitoring using the **enable cir-monitor** and **disable cir-monitor** console (Talk 5) commands.



## Congestion Monitoring

When you enable congestion monitoring, the data rates for the circuit will not be monitored during transmit or receive. The BECN and FECN bits will be set under the following conditions:

- The input device is low on receive buffers and the fair value for the interface is exceeded.
- 80% of the configured maximum queue depth is exceeded.

A frame will be discarded if the configured maximum queue depth is exceeded by receiving an incoming frame. If a frame is to be discarded, then FR will discard the first frame in that has the DE bit set and should be forwarded. If no frame with the DE bit is found, then the received frame will be discarded instead of being forwarded. Congestion monitoring is an optional feature that can be set per interface. Congestion monitoring is enabled by default. You can disable it with the **disable congestion-monitor** configuration command and reenabling it with the **enable congestion-monitor** command. You can also dynamically enable and disable congestion monitoring using the **enable congestion-monitor** and **disable congestion-monitor** console (Talk 5) commands.

## No Monitoring

When neither CIR nor congestion monitoring are enabled, the send and receive data rates will not be monitored and neither BECN nor FECN will be set. The DE bit will not be used when determining which frame to discard during congestion. Instead, if the input device is low on receive buffers and the fair value for the interface is exceeded, or if the outbound queue depth for the FR circuit reaches 100, the input frame will be discarded.

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## Bandwidth Reservation over Frame Relay

For information on bandwidth reservation over FR, refer to “Using Bandwidth Reservation and Priority Queuing” and “Configuring and Monitoring Bandwidth Reservation” in *Using and Configuring Features*.

The bandwidth reservation system (BRS) should be configured to prioritize the data frame fragments if fragmentation is enabled on an interface. See “Fragmentation Over a Frame Relay Interface” for details.

---

## Fragmentation Over a Frame Relay Interface

Voice over Frame Relay (VoFR) is a method to transmit voice packets over an FR circuit. If you plan to use one FR circuit to carry both real-time (voice) and data traffic, you should configure that circuit to fragment the data traffic, especially if the link is relatively slow, for example, 64 kbps. Fragmentation is also needed for circuits on interfaces that carry voice traffic and for circuits on interfaces that do not carry voice traffic themselves but communicate with interfaces that carry voice traffic.

There are two types of fragmentation, end-to-end and interface (or UNI/NNI). Interface-level fragmentation has not been implemented by any major FR switch vendors and so it is not available from any FR service providers. Per the FR implementation agreement, FRF.12, end-to-end fragmentation is supported for PVCs only. Therefore, an interface with voice support can be used to support FR PVCs, but not SVCs.

## Using Frame Relay

You can configure the fragment sizes. Fragment sizes are not negotiated or communicated between interfaces and therefore may be different for two interconnected PVCs. The fragment size may vary from one link or PVC to another depending on the access speed of the link, the CIR of the PVC, and whether this interface is actually carrying real-time data or is communicating with another router whose interface is carrying real-time data. Other factors to consider when configuring fragmentation for voice over frame relay include committed burst size, BRS traffic classes and queue depths if BRS is configured, the number of global buffers created, and the number of receive buffers allocated to each interface.

Because of the overhead associated with fragmentation, it is best to keep the fragment size as large as possible while still maintaining high quality real-time data communications.

If a circuit transmits real-time data, you should configure the Bandwidth Reservation System (BRS) in addition to FR fragmentation on that interface and circuit. Enabling BRS can give higher priority to real-time data over other data. As a result, real-time data can be interleaved between other data that has been fragmented so that the queueing delay for the real-time data can be minimized.

BRS is required only for circuits that will actually be sending real-time data and other data. Other circuits on the interface, or circuits that communicate with interfaces that support real-time data, do not specifically need BRS support to allow interleaving.

Refer to the **assign** command in the chapter “Configuring and Monitoring Bandwidth Reservation” in the *Using and Configuring Features* for more information about configuring BRS.

**Note:** You can configure fragmentation either for an interface or for a circuit (also called a PVC). If you configure fragmentation for a PVC, you must use the **add permanent-virtual-circuit** or the **change permanent-virtual-circuit** command. The following example shows the **add permanent-virtual-circuit** command:

```
FR 1 Config>add perm 18
Committed Information Rate (CIR) in bps[64000]?
Committed Burst Size (Bc)in bits [64000]? 4800
Excess Burst Size (Be) in bits [0]?
Assign circuit name : :? VoFRcircuit1
Is circuit required for interface operation [N]?
Enable circuit for voice forwarding [N]?
Do you want to have end-to-end fragmentation performed [N]? y
Fragment size (50 to 1000) [256]?
Fragmented packet reassembly timer (3 to 10 seconds) [256]?
```

---

## Voice Forwarding Over Frame Relay

Voice forwarding over FR will enable a voice-capable or non-voice capable router to forward FRF.11 encapsulated packets, that is, voice packets, between FR PVCs without using a native voice adapter. This will allow a voice-capable router to multiplex voice and data over the same virtual circuit across the FR network. The voice-forwarding router will then route the received data using the protocol stack associated with the received traffic and forward the voice traffic to another PVC over the same or another FR interface. In a typical configuration, the voice traffic is forwarded to a locally attached voice-capable device.

Even though it is a DCE-like function, voice packet forwarding will be done over virtual circuits defined as DTEs. Voice forwarding will be allowed for PVCs only because voice over FR is supported for PVCs only.

A PVC that will be used for voice packet forwarding must be enabled through configuration to do so. In fact, a pair of PVCs on assumedly different FR interfaces must be defined to forward voice packets to each other. When you enable a PVC for voice forwarding, you must provide the net number and DLCI of the PVC to which the PVC should forward the voice packets. FR will forward all voice packets between the pair of PVCs defined to do voice forwarding.

---

### Tips for Configuring the 2216 for VoFR

**Note:** The 2216 does not originate voice traffic over FR, but it requires specialized configuration when it is used to forward voice traffic over FR.

Through the use of statistical multiplexing, frame relay networks provide an excellent transport medium for data, but represent somewhat of a challenge for voice. The transit delay for each packet forwarded through a frame relay network is potentially different from that of the previous packet. And although frame relay networks ensure proper sequencing of frames, they do not ensure delivery of all packets; retry and recovery are left to higher layers. The delay of a given packet is mostly affected by the amount of additional network traffic present when the packet is being forwarded. There is a general rule of thumb that the round-trip response time for a voice packet should not exceed 250 milliseconds (ms); otherwise, the callers will begin talking over one another. To maximize the quality of the voice calls, your router network can be tuned to minimize the transient delay of voice packets.

There are a number of configurations that can be used to support Voice over Frame Relay (VoFR) and each one requires different tuning considerations. Frame relay fragmentation plays a key role in the configuration if the voice will be carried over relatively slow links (for example, 64 kbps). The frame relay CIR and committed burst size, BRS traffic classes and allowable queue depths, the number of global buffers created, and the number of receive buffers allocated to each interface also require consideration.

### Configuring Frame Relay Interfaces

Fragmentation is required for all PVCs on any interface that will be used for voice or any other high priority, real-time data. There are two types of fragmentation: end-to-end and interface (or UNI/NNI). Interface-level fragmentation has not been implemented by any major FR switch vendors, and so it is not available through any FR service providers. Per the Frame Relay Forum implementation agreement, FRF.12, end-to-end fragmentation is supported only for PVCs. Therefore, an interface with voice support should not be used to support FR SVCs.

Fragmentation is necessary to minimize the amount of delay in queuing and transmitting voice packets. Fragmentation should be used for all PVCs that exchange data over an interface that is supporting voice. This means that a router that does not support voice still needs to perform fragmentation if it communicates with another router that is supporting voice over the same interface.

Fragment sizes may vary between FR interfaces, depending upon the access speed of the link, the CIR of the PVC, and whether this interface is actually carrying voice or just communicating with another router whose interface is carrying voice. Fragment sizes are not negotiated or communicated between interfaces, and therefore may be different for two interconnected PVCs. Because of the overhead associated with fragmentation, it is best to keep the fragment size as large as possible while still maintaining high-quality voice communications. The most

## Using Frame Relay

important thing to remember is the 250-millisecond round trip delay limit. That means that any given component in the network must minimize its portion of the delay and yet maximize its efficiency.

When voice and data are multiplexed over the same PVC, the FR burst size and burst interval are also important in reducing the amount of delay incurred by voice packets. The burst interval, or  $T_c$ , is calculated by  $B_c/CIR$  (committed burst size divided by CIR). This specifies the duration of the burst. The burst size is the number of bits the router is configured to send during  $T_c$ . It is normally  $B_c+B_e$ , but can be more or less, depending on whether CIR or congestion monitoring is enabled and whether any congestion indications have been received.

Assume for example, you have a CIR of 64 kbps, a  $B_c$  of 64 kbs, and a  $B_e$  of 0; in this case,  $T_c$  is equal to one second. The router will allow a burst of up to 64 kbs anytime during that 1-second period. If there is data queued for the circuit, then the 64 kbs will be sent right at the beginning of the interval. The router must now wait until the next  $T_c$ , that is, the next second, before it can send any more data. This works well for file transfers and also works well for voice alone because the voice interface sends data to the FR interface at a steady, predictable rate, thereby eliminating the burst. But if the PVC is being used to transmit both voice and data traffic, then the voice could be queued for up to one second waiting for the next  $T_c$  interval, and this delay is unacceptable.

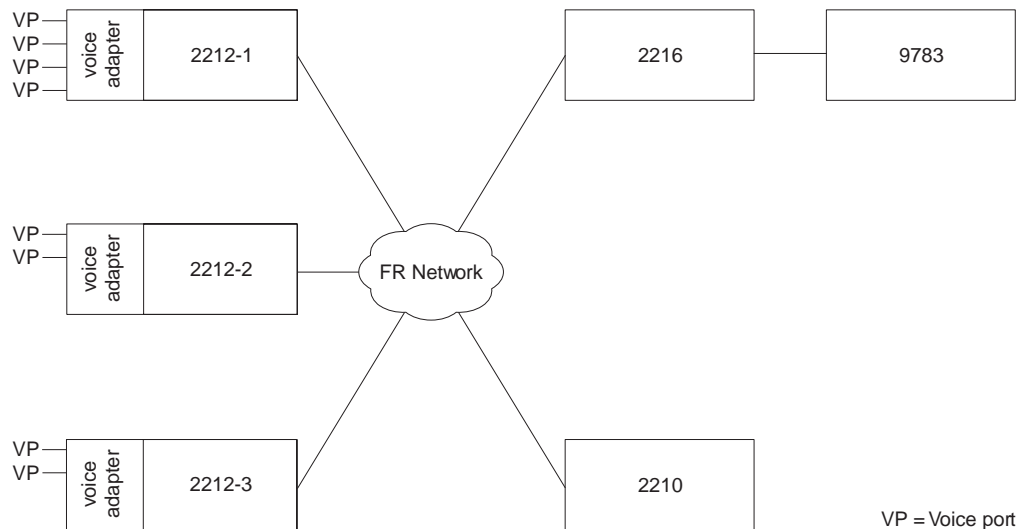


Figure 44. A Sample VoFR Configuration

Assume in this configuration that the 2212s, 2210s, and the 2216 each have a T1 access rate link to the FR network. The 2212s and 2210 each have a single PVC leading to the 2216. The 2216 therefore has a single PVC to each of the routers. PVCs to other routers are assumed to be on the same link. The 2216 also has a back-to-back FR link to the IBM 9783 Voice FRAD at T1 speed.

The following list describes the configuration considerations that must be made when configuring the 2212s:

- If the PVC will be carrying voice only, using the defaults for the voice adapter interface and FR interface should be sufficient. However, whether the PVC is carrying voice and data or just voice, you need to be aware of the amount of data each voice call generates to ensure that you have the bandwidth available

to carry the traffic. The amount of data a voice port generates depends upon the vocoder and rate configured. This information can be gathered from Table 69.

As an example, assume a vocoder rate of 9.6 kbps. The 9.6 kbs represents the amount of data, minus headers, that will be used for the call, assuming no silence suppression. If frame packing is not used, the actual bandwidth used is 12 800 bps per call. So a PVC with a 64-kbps CIR can carry only four voice calls at the 9.6-kbps rate. A PVC carrying voice only does not need to be fragmentation capable; it is carrying only voice, and voice packets are not fragmented.

Table 69. Data Generated by a Voice Port

Vocoder	Bits per second with overhead	Bytes per frame	Packets per second
4800	8000	15	67
7500	10 670	20	67
8000	10 400	26	50
9600	12 800	25	67
16 000	19 200	36	67
32 000	35 200	66	67

- All PVCs that are not carrying voice, but are on the same interface with a PVC that is carrying voice, must be enabled for fragmentation. The fragmentation size depends upon the access rate, the number of voice ports supported on the interface, and the amount of delay that you can tolerate in the voice connection. For example, with the vocoder and rate given above, the portable voice module (PVM), that is, the voice adapter, will transmit a voice frame every 15 ms. It is best to minimize the queuing delay for each voice packet, but some amount of queuing is tolerable. If you assume that a 30-ms delay is tolerable, then the fragment size on the non-voice capable PVCs on a 64-kbps line should be about 240 ( $64\ 000 * 0.030$ ) bytes. If the PVC is on a T1 line, then the fragmentation may not be necessary if the 30-ms delay is acceptable ( $1\ 544\ 000 * 0.030 = 5790$  bytes).
- PVCs that are carrying both voice and data need more tuning. This is when you must not only tune the fragment size, but also the CIR and burst size to accommodate the voice and data mix. Again, you must consider the access rate, the number of calls, and the vocoder and rate.
- For example, assume that 2212-1 shown in Figure 44 on page 518 has four voice ports that can all be active at the same time. In testing, it was found that a 60-ms delay in the voice at the FR interface was tolerable. This means that the burst interval of the PVC,  $T_c$ , should be set to 60 ms.  $T_c$  is not directly configurable, but, as stated above, is determined by  $B_c/CIR$ . If the CIR is 64 kbps, setting  $B_c$  to 3840 bits results in a  $T_c$  of 60 ms.  $B_e$  is set to zero;  $B_e$  can be set greater than zero if the FR network will allow the PVC to burst above its CIR. This means that the PVC can send 3840 bits (480 bytes) per 60 ms. If it does this, then it will achieve a send rate of 64 kbps ( $60\ ms = .06\ seconds; 3840/.06 = 64\ 000\ bps$ ). The four voice calls will each generate one 25-byte frame every 15 ms. This means that in a 60-ms interval, the voice ports will be sending 400 bytes ( $25\ bytes * 4\ frames * 4\ calls$ ) per interval. This leaves 80 bytes per  $T_c$  to

## Using Frame Relay

send data. Therefore, the fragment size should be set to 74 (80 - 6 bytes of overhead). In order for Tc to be strictly honored for a PVC, you must enable CIR monitoring for this interface.

As another example, assume that you have only two voice calls over the same PVC above. Tc should still be 60 ms, meaning that Bc must still be set to 3840. However, the fragment size will change, because a larger fragment may now be sent in the same Tc interval with the voice packets. In this case, the fragment size should be set to 274 bytes (480 - (25 \* 4 \* 2) - 6).

- FR supports a minimum Tc of 30 ms. The voice packets are small by rule, so lowering the Tc will not affect the performance of the voice traffic. However, using a small Tc forces the fragment size to be smaller and small fragment sizes are inefficient in terms of bandwidth, processor utilization, and global buffer use. It is best to find the largest Tc and therefore the largest fragment size that can be used to maintain good voice quality.

The considerations for tuning the 2216 are the same as for the 2212 because it is performing voice forwarding between the PVMs in the 2212s and the IBM 9783 Voice FRAD.

The 2210 is not sending any voice traffic; however, it is communicating with the 2216 interface that is sending voice traffic. In this case, the 2210 does not need any special tuning other than enabling the PVC for fragmentation. The 2210 PVC does not really need to fragment its outgoing packets, but fragmentation must be enabled to allow it to receive fragmented packets. Therefore, the fragmentation size for this PVC should be set to the MTU for the interface, or 8190, which is the maximum MTU for an FR interface. In either case, the 2210 will not be fragmenting frames it sends but will be reassembling those sent to it by the 2216.

Depending upon the number of voice calls supported and the access rates, you may also need to increase the number of input buffers per interface. Increased input buffers are required because of the queuing delays caused when FR runs burst timers. What generally happens on a T1 line is that the PVC will fill its burst size immediately and then pause for Tc (60 ms in the above example) before sending again. This will mean that the circuit will queue 60 ms worth of voice frames before sending again. Flow control mechanisms in the router can cause voice packets to be discarded so that transmission is affected before you notice a problem with the voice quality. Transmission problems are indicated when voice calls are hung up by the voice adapter or a voice call cannot be initiated even when the bandwidth is available.

In these cases, it may be necessary to increase the number of receive buffers on both the FR and voice adapter interfaces. The best way to monitor dropped frames is by using the `Talk 5 error` and `interface` commands. If input discards on the voice adapters or missed frames on either the voice or FR interfaces are detected, you should increase the number of receive buffers. However, input and output discards on the FR interfaces may be normal and acceptable if any of the FR circuits are being overloaded with data, for example, when the 2216 is attempting a large file transfer while four voice calls are active.

## Configuring BRS

It is necessary to configure BRS on all interfaces that are supporting both voice and data. BRS can be used to control both the number of buffers that can be queued for a given circuit and the priority given to the data that is being queued.



The minimum and maximum queue depths are configured per circuit at the BRS level. These queue depths apply to each of the four queues in every traffic class that BRS maintains. The minimum queue depth determines when BRS will discard incoming frames when the input device is low on receive buffers. Being low on input receive buffers means that the input device has  $x$  or fewer remaining buffers available in which to receive data, where  $x$  is equal to the *low* count as displayed by the talk 5 **queue** command.

BRS will return the buffer to the input device if the input device is low on input buffers and if the number of buffers in the queue to which the input frame would be added is currently equal to or greater than the minimum queue depth and less than the maximum queue depth. Regardless of whether or not the input device is low on buffers, the maximum queue depth determines the maximum number of buffers that will be queued in the priority queue. The minimum and maximum queue depth values should be increased along with the number of receive buffers per interface when input discards are detected. Input discards are displayed per interface by using the talk 5 **statistics** command.

Next, consider the traffic classes that are used to give bandwidth preference to the voice traffic. Traffic class definitions need be defined only if both voice and data will be multiplexed over the same PVC, because traffic classes do not interfere or interrupt each other across circuits. Voice should normally be given priority over any other traffic type for a PVC. To give priority to voice, you have the following two options:

1. Create a named traffic class. This results in two traffic classes, because the LOCAL class is always created and is used for traffic generated internally by the router, that is, RIP and PING. Assign all protocols to the traffic class that you created and assign the highest priority in that class to voice traffic (P\_VOFR) so that it is sent first, before all other protocols. Higher priority protocol data within a class is always sent before lower priority data. Protocol data assigned to the same priority within a class is sent in FIFO order. A potential problem is that if congestion occurs, voice traffic is always sent first and it is possible that the other protocols will never get sent. This condition is called *starving*.
2. Create a super traffic class and assign voice to it. Assign the other protocols to different traffic classes, assigning bandwidth percentages to each class as required. The super class does not have a bandwidth percentage assigned to it. Traffic queued in this class will be sent before data in any other traffic class. Using multiple traffic classes allows you to give preference to high-priority protocols without starving out lower-priority protocols.

BRS circuit classes may also be necessary to give bandwidth preference to PVCs carrying voice over those carrying only data. Circuit class definitions are only necessary when the sum of the CIRs for the circuits on the interface exceeds the access rate of the link. If the CIR total does not exceed the access rate, then the bandwidth percentages assigned to the circuit classes are not used because the FR traffic shaping function (that is, CIR monitoring) will override the circuit class bandwidth allocations. If the CIR total does exceed the access rate, then circuit classes should be defined with those PVCs carrying voice having higher bandwidth percentages than those carrying data only.

---

## Displaying the Frame Relay Configuration Prompt

To access the FR configuration environment:

1. At the OPCON prompt (\*), type **talk 6**.

## Using Frame Relay

2. At the configuration prompt (Config>), enter the **list devices** command to see a list of interfaces configured on the router.
3. Enter the **network** command to display the FR configuration prompt. The network number is the number of the FR interface.

```
Config>network
Network number [0]? 2
Frame Relay user configuration
FR 2 Config>
```

4. At the FR interface configuration prompt (for example, FR 2 Config>), use the commands discussed in this chapter to configure FR parameters.

---

## Frame Relay Basic Configuration Procedure

This section outlines the minimum configuration steps that you are required to perform to get the FR protocol up and running. If you desire any further configuration information and explanation, refer to the configuration commands described in this chapter.

**Note:** You must restart the router for new configuration changes to take effect.

- **Select FR management.** The FR Local Management Interface (LMI) protocol defaults to ANSI. You have the option of connecting to a network using the Interim LMI (REV1), ANSI T1.617 Annex D management, or ITU-T/CCITT Q.933 Annex A management. Use the **enable** and **set** commands to enable and set the required management.
- **Add a PVC.** Add any required PVCs that are needed if FR management is disabled or orphan circuits are disabled. If you want to bridge over an FR PVC, or if you want to run APPN over an FR PVC, you also must configure that PVC. Use the **add permanent-virtual-circuit** command.
- **Configure FR destination addresses.** If you are running a protocol such as IP or IPX over the FR interface, and are interconnecting with devices not supporting the Address Resolution Protocol (ARP) or Inverse ARP on FR, use the **add protocol-address** command to add the static protocol and address mapping.
- **Configure Bandwidth Reservation over Frame Relay.** In addition to the basic FR configuration, which must be done, you can also configure Bandwidth Reservation (an optional feature) over FR. For information on configuring Bandwidth Reservation, refer to “Using Bandwidth Reservation and Priority Queuing” in *Using and Configuring Features*.
- **Configure Discard Eligibility.** You can configure Discard Eligibility (DE) congestion control using Bandwidth Reservation. For information on configuring Discard Eligibility, refer to “Using Bandwidth Reservation and Priority Queuing” in *Using and Configuring Features*.
- **Configure Data Compression.** You can configure data compression for FR. For information on configuring data compression, refer to “Configuring and Monitoring Data Compression” in *Using and Configuring Features*.
- **Configure Data Encryption.** You can configure data encryption for FR. For information on configuring data encryption refer to “Using and Configuring Data Encryption” in *Using and Configuring Features*.

---

## Enabling Frame Relay PVC Management

There are three management options under Frame Relay:

- Interim Local Management Interface Revision 1
- ANSI T1.617 Annex D management
- ITU-T/CCITT Q.933 Annex A management.



## Using Frame Relay

FR defaults to ANSI enabled. If you want to change management types, or if you want to re-enable ANSI management, use the following procedure. Enabling management over FR is a two-step process:

1. Enter the **enable lmi** command at the FR Config> prompt to enable management activity.
2. Enter the **set lmi-type** command to select the type of management for the interface.

See Table 70 for details of the management types available using the **set** command.

**Note:** The default value of the LMI network type is UNI (user-to-network interface). This is the most common configuration required when attaching the device to a public FR network. If an NUI (network-to-user) or NNI (network-to-network) interface is required, use the **set LMI-network-type** command to configure the interface appropriately.

An example of how to set these management types is shown after the table. Also, refer to the **enable** and **set** command sections in this chapter for more information.

Table 70. Frame Relay Management Options

Command	Options	Description
set	lmi-type rev1	Conforms to LMI Revision 1 (Stratacom s Frame Relay Interface Specification)
set	lmi-type ansi	Conforms to ANSI T1.617 ISDN-DSS1-Signalling Specification for Frame Relay Bearer Service (known as Annex D)
set	lmi-type ccitt	Conforms to Annex A of ITU-T/CCITT Recommendation Q.933 - DSS1 Signalling Specification for Frame Mode Basic Call Control.

**Example:**

```
enable lmi
set lmi-type ansi
```

---

## Enabling Frame Relay SVC Management

FR SVC management is automatically enabled when SVCs are enabled.



---

## Chapter 42. Configuring and Monitoring Frame Relay Interfaces

This chapter describes the Frame Relay configuration and operational commands and includes the following sections:

- “Frame Relay Configuration Commands”
- “Accessing the Frame Relay Monitoring Prompt” on page 562
- “Frame Relay Monitoring Commands” on page 562
- “Frame Relay Interfaces and the GWCON Interface Command” on page 577
- “Frame Relay Dynamic Reconfiguration Support” on page 579

### Notes:

1. For information on monitoring bandwidth reservation over Frame Relay, refer to “Configuring and Monitoring Bandwidth Reservation” in *Using and Configuring Features*.
2. The **add dev fr** command from the `Talk 6 Config>` command is used to create Frame Relay subinterfaces. See “Subinterfaces for Frame Relay” on page 499 for more information.

---

## Frame Relay Configuration Commands

This section describes the Frame Relay configuration commands. Enter all commands at the `Frame Relay n>` prompt, where *n* represents the interface number. You must restart the router for new configuration changes to take effect. Table 71 shows the commands. To access the `Frame Relay n>` prompt, perform the following steps:

1. At the `OPCON` prompt (\*), type **talk 5**.
2. At the `GWCON` prompt (+), enter the **interface** command to see a list of interfaces configured on the router.
3. Select the Frame Relay interface that you will configure.
4. Type **exit**.
5. At the `OPCON` prompt (\*), type **talk 6**.
6. At the `Config>` prompt, enter the **network** command followed by the network number of the frame relay interface. For example:

```
Config> net 2
Frame Relay user configuration
FR 2 Config>
```

Table 71. Frame Relay Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Adds PVCs, Required PVC groups, SVCs, and destination protocol addresses to the Frame Relay interface.
Change	Modifies a PVC, SVC, or Required PVC group previously defined by the <b>add</b> command.
Disable	Disables any enabled Frame Relay features.
Enable	Enables Frame Relay features such as circuit monitoring, management options, multicast, protocol-broadcast, fragmentation, and orphans.
List	Displays the current configuration of the LMI, PVCs, Required PVC groups, SVCs, HDLC information, and protocol addresses.

## Configuring Frame Relay Interfaces (Talk 6)

Table 71. Frame Relay Configuration Commands Summary (continued)

Command	Function
LLC	Configures LLC parameters on the Frame Relay interface. These LLC parameters are required when running APPN over the Frame Relay interface.
Remove	Deletes any previously added PVCs, SVCs, or required PVC groups (if empty), or protocol addresses.
Set	Configures the Frame Relay management options and parameters (N1-parameter, N2-parameter, N3-parameter, P1 parameter, and T1-parameter). Configures the physical-layer parameters for FR serial interfaces. Sets the maximum frame size.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

**Note:** In this section, the terms *circuit number* and *PVC* are synonymous with the term DLCI (Data Link Circuit Identifier).

### Add

Use the **add** command to add a circuit, required PVC group, or destination protocol address supported by the Frame Relay interface.

#### Syntax:

```
add                frame-handler-pvc  
                    permanent-virtual-circuit . . .  
                    protocol-address . . .  
                    pvc-group . . .  
                    switched-virtual-circuit . . .
```

#### frame-handler-pvc

Adds frame handler support to allow routed, bridged, voice, and DCE traffic over the same interface.

#### Example:

```
FR 4 config> add frame-handler-pvc  
Circuit Number [16]?  
Committed Information Rate (CIR) in bps [64000]?  
Committed Burst Size (Bc) in bits [64000]?  
Excess Burst Size (Be) in bits [0]?  
Assign Circuit name []?  
Network number of FH partner PVC [0]?  
Circuit number of FH partner PVC [16]?  
Maximum outbound queue depth (in number of packets) [10]? 1
```

#### Circuit Number

Indicates the circuit number for this PVC.

**Valid Values:** 16 to 1007. The circuit number must be unique with respect to all other PVCs and FH PVCs on this interface and all associated subinterfaces.

#### Committed Information Rate

Indicates the committed information rate (CIR). The CIR can be a value in the range 300 bps to 2 048 000 bps. For more information, see “Committed Information Rate (CIR)” on page 508. The maximum is the value of the default CIR configured for the interface.

## Configuring Frame Relay Interfaces (Talk 6)

**Note:** The default value is determined according to the CIR defaults set at the interface level.

### Committed Burst Size

The maximum amount of data in bits that the network agrees to deliver during a measurement interval equal to committed burst (Bc) size / CIR seconds. The range is 300 to 2 048 000 bits. The maximum value is the value of the default committed burst configured for the interface. See “Committed Burst (Bc) Size” on page 509 for more information.

**Note:** The default value is determined according the Bc defaults set at the interface level.

### Excess Burst Size

The maximum amount of uncommitted data in bits in excess of committed burst size that the network attempts to deliver during a measurement interval equal to (Committed Burst Size/CIR) seconds. The range is 0 to 2 048 000 bits. The maximum value is the value configured for excess burst size for the interface. For additional information, see “Excess Burst (Be) Size” on page 509.

**Note:** The default value is determined according to the Be defaults set at the interface level.

### Assign Circuit Name

Indicates the ASCII string that is assigned to describe the PVC. The default is *unassigned*.

### Network number of FH partner PVC

Specifies the net number of the partner frame handler PVC.

### Circuit number of FH partner PVC

Specifies the circuit number of the partner frame handler PVC.

### Maximum outgoing queue depth

Specifies the maximum number of frames that may be queued on the outbound queue for a frame handler PVC and is used during congestion processing.

**Valid Values:** 5 to 100

**Default Value:** 10

### permanent-virtual-circuit

Adds a PVC to the Frame Relay interface beyond the reserved range 0 through 15. The maximum number of PVCs that can be added is approximately 992, but the actual number of PVCs that the interface can support depends upon these conditions:

- The throughput required for each PVC
- The line speed
- The types of protocol running on the interface
- The number of local management interface PVC information elements that can fit in the maximum frame size

### Example:

```
add permanent-virtual-circuit
Circuit Number [16]?
Committed Information Rate (CIR) in bps [64000]?
Committed Burst Size (Bc) in bits [64000]?
Excess Burst Size (Be) in bits [0]?
```

## Configuring Frame Relay Interfaces (Talk 6)

```
Assign Circuit name []?
Is circuit required for interface operation [N]? y
Does the circuit belong to a required PVC group [N]? y
What is the group name []? group1
Do you want to have data compression performed [Y]?
Do you want to have end-to-end fragmentation performed [Y]?
Fragment size (50 to 8190) [256]?
Fragmented packet reassembly timer (3 to 10 seconds) [3]?
Enable circuit for voice forwarding [N]? y
Network number of voice forwarding PVC [0]?
Circuit number of voice forwarding PVC [16]?
Do you want to have data encryption performed [N]? y
Should the encryption algorithm be CDMF (CDMF) or triple-DES (3DES) [CDMF]?
Data encryption requires a key that is 16 hexadecimal characters long for CDMF,
48 hexadecimal characters long for 3DES.
```

You will be asked to enter the key twice for security reasons

Please enter the key for the first time now

A valid encryption key has been entered

Please confirm the key by entering it again

The encryption keys match - the key has been accepted

### Circuit Number

Indicates the circuit number for this PVC.

**Valid Values:** 16 to 1007. The circuit number must be unique with respect to all other PVCs and FH PVCs on this interface and all associated subinterfaces.

### Committed Information Rate

Indicates the committed information rate (CIR). The CIR can be either 0, or a value in the range 300 bps to 2 048 000 bps. For more information, see “Committed Information Rate (CIR)” on page 508. The maximum is the value of the default CIR configured for the interface.

**Note:** The default value is determined according the CIR-defaults set at the interface level.

### Committed Burst Size

The maximum amount of data in bits that the network agrees to deliver during a measurement interval equal to committed burst (Bc) size / CIR seconds. The range is 300 to 2 048 000 bits. The maximum value is the value of the default committed burst configured for the interface. For additional information, see “Committed Burst (Bc) Size” on page 509.

#### Notes:

1. The default value is determined according the Bc defaults set at the interface level.
2. CIR configured as 0 is not supported for FH PVCs.

### Excess Burst Size

The maximum amount of uncommitted data in bits in excess of committed burst size that the network attempts to deliver during a measurement interval equal to (Committed Burst Size/CIR) seconds. The range is 0 to 2 048 000 bits. The maximum value is the value configured for excess burst size for the interface. For additional information, see “Excess Burst (Be) Size” on page 509.

**Note:** The default value is determined according the Be defaults set at the interface level.

## Configuring Frame Relay Interfaces (Talk 6)

### Assign Circuit Name

Indicates the ASCII string that is assigned to describe the PVC. The default is *unassigned*.

### Is the circuit required for operation?

Specify **Y** or **N** to indicate whether the circuit is required for interface operation.

### Does the circuit belong to a required PVC group?

This prompt is displayed only for circuits that are required. Specify **Y** or **N** to indicate whether the circuit should belong to a required PVC group.

### What is the group name?

Enables you to specify the name of the required PVC group when the PVC is defined as belonging to a required group. Enter a question mark (?) for a list of currently defined groups.

### Do you want to have compression performed?

Enables you to specify whether or not the circuit will compress data packets. This question appears only if compression is enabled on the interface.

**Note:** If you enable compression on a PVC and exceed the interface's compression circuit limit, you will get a message. Compression will be performed on the circuit, if possible, that is, the active compression limit has not been exceeded when the circuit becomes active. Compression limit includes the number of compression contexts allocated to SVCs as well as PVCs.

### Enable circuit for voice forwarding?

Enables you to specify whether or not the circuit will forward voice packets. If you specify **Y** (yes), you must specify the network and circuit number of the PVC to which this PVC will forward voice frames.

### Do you want to have end-to-end fragmentation performed?

Enables you to specify whether or not the circuit will perform fragmentation across the entire circuit. This question appears only if end-to-end fragmentation has been enabled on the interface. If UNI/NNI fragmentation is enabled, all circuits on this interface are automatically enabled for fragmentation, and this question does not appear.

When you specify the fragment size and reassembly timer values, you can override the defaults for the end-to-end fragment size and reassembly timer values configured for this interface.

### Do you want to have data encryption performed?

Enables you to specify whether or not the circuit will encrypt data packets. This question appears only if encryption is enabled on the interface. The prompts for the encryption key and algorithm will only appear if you respond **Y** (yes) to this question.

**Specifying the Encryption Key:** You must specify the encryption key value in hexadecimal characters.

**Valid Values:** 16 hex characters for CDMF, 48 hex characters for 3DES

## Configuring Frame Relay Interfaces (Talk 6)

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### protocol-address

This command adds statically configured destination protocol (protocol-name) addresses to the Frame Relay interface. Statically configured destination protocol addresses are useful if neither Inverse ARP nor ARP is an option, or for other reasons such as security. Adding protocol name and address mappings (static ARP) is less efficient than Inverse ARP or ARP.

- Inverse ARP is the preferred, efficient method because of dynamic address mapping with no broadcasts.
- ARP is recommended if Inverse ARP is not an option. It is less efficient than Inverse ARP because it uses address broadcast and mappings are relearned at regular intervals.

This parameter prompts you for different information depending on the type of protocol that you are adding.

### Example:

```
add protocol-address  
Protocol name or number [IP]?
```

### IP protocol:

```
IP Address [0.0.0.0]?  
Circuit Number or name [16]?
```

### IPX protocol:

```
Host Number (in hex)[]?  
Circuit Number or name [16]?
```

### AppleTalk Phase 2 protocol:

```
Network Number (1-65279) []?  
Node Number (1-253) []?  
Circuit Number or name[16]?
```

### DN protocol:

```
Node address [0.0]?  
Circuit Number or name[16]?
```

### Protocol name or number

Defines the name or number of the protocol that you are adding. If you should specify an unsupported protocol, the system will prompt you with the error message:

```
Unknown protocol name, try again
```

For example, you may have erroneously specified one of the following:

Prot#	Name
0	IP
4	DN
7	IPX
22	AP2

To see a list of supported protocol types, type ? at the Protocol name or number [IP]? prompt.

### IP Address

Defines the 32-bit Internet address in dotted-decimal notation of the remote IP host.



## Configuring Frame Relay Interfaces (Talk 6)

### Host Number

Defines the 48-bit IPX node address of the remote IPX host.

### Network Number

Defines the AppleTalk Phase 2 network number of the remote AppleTalk host.

### Node Number

Defines the node number of the interface attached to the remote AppleTalk host.

### Node address

Defines the DECnet node address of the remote DECnet host. Configure the node address in the format *x.y*, where *x* is a 6-bit area address and *y* is a 10-bit node number.

### Circuit Number or name

Defines the PVC by DLCI or name or SVC by name that this remote protocol address is associated with.

### **pvc-group** *groupname*

Adds a required PVC group name.

**Note:** SVCs may not belong to a required PVC group.

### **switched-virtual-circuit**

Adds a switched virtual circuit (SVC). The SVC will act similar to a PVC except that the SVC's bandwidth will be allocated for it dynamically by the FR network only when the SVC is active. The number of SVCs that can be added is similar to the number of PVCs that can be added in that the number depends on the throughput required for each circuit, the line speed, etc. However, since the bandwidth for an SVC is only reserved when the SVC is active, it may be possible to support more SVCs over an interface than PVCs.

```
FR 4 Config>add switched-virtual-circuit
Circuit name []? svc01
Remote party number []? 12345
Remote party number numbering plan (E.164 or X.121) [E.164]?
Remote party number type (Unknown or International) [International]?
Remote party subaddress in hexadecimal []? 01
Remote party subaddress format (private or NSAP) [private]1?
Requested outgoing Committed Information Rate (CIR) in bps [64000]?
Minimum acceptable outgoing Committed Information Rate (CIR) in bps [64000]?
Requested incoming Committed Information Rate (CIR) in bps [64000]?
Minimum acceptable incoming Committed Information Rate (CIR) in bps [64000]?
Requested outgoing Committed Burst size (Bc) in bits [64000]?
Requested incoming Committed Burst size (Bc) in bits [64000]?
Requested outgoing Excess Burst size (Be) in bits [0]?
Requested incoming Excess Burst size (Be) in bits [0]?
Idle timer in seconds [60]?
Establish circuit to learn remote protocol addresses [Y]?
Is multicast required for this circuit [Y]?
Are call-ins allowed for this circuit [Y]?
```

### Circuit name

Specifies the circuit name for the SVC. This name will be used to associate the call with both a protocol and a BRS definition and will be used to identify a connection instead of a circuit number.

**Valid Values:** A 1 to 32 character ASCII string

**Default Value:** The name is required and must be unique for this interface

### Remote party number

Specifies the remote destination's Frame Relay address.

## Configuring Frame Relay Interfaces (Talk 6)

**Valid Values:** A 1 to 20 character string of decimal digits

**Default Value:** None

### Remote party numbering plan

Specifies the format of the remote party number. The numbering plan must match that used by the FR network.

**Valid Values:** E.164 (ISDN) or X.121 (Data)

**Default Value:** E.164

### Remote party number type

Specifies the destination Frame Relay party number type. The number type must match that used by the FR network.

**Valid Values:** International or Unknown

**Default Value:** International

### Remote party subaddress

Specifies the party entity (for example, protocol) within the destination node. If the subaddress is used, it will be matched to the remote device's subaddress. The subaddress at both ends of the connection must be the same.

The format of the **remote party subaddress** can be:

- NSAP

The number of digits entered must be even and in the range of X'0' - X'F'.

- Private

If the encoding is BCD, then an odd number of digits in the range of 0 - 9 can be entered.

If the encoding is not BCD, then an even number of digits in the range of X'0' - X'F' can be entered.

The combination of remote party number and remote party subaddress must be unique on this interface and any associated subinterface. If parallel connections between two router interfaces are required, the subaddress must be used to uniquely identify each switched virtual connection definition.

**Valid Values:** 1 - 40 character hexadecimal string

**Default Value:** None

### Requested outgoing throughput (CIR)

Specifies the requested outgoing CIR. The network will provide this bandwidth, if available.

**Valid Values:** The CIR can be either 0, or a value in the range 300 bps to 2 048 000 bps.

**Note:** The valid values for a FR interface on a HSSI adapter are: 0 or 300 - 52 000 000

**Default Value:** Default value is determined according to CIR-defaults at the interface level

## Configuring Frame Relay Interfaces (Talk 6)

### Minimum acceptable outgoing Committed Information Rate (CIR)

Specifies the minimum CIR that will be accepted if the network cannot provide the requested CIR.

**Valid Values:** The CIR can be either 0, or a value in the range 300 bps to 2 048 000 bps with a maximum of the **requested outgoing throughput (CIR)**.

**Note:** The valid values for a FR interface on a HSSI adapter are: 0 or 300 - 52 000 000

**Default Value:** Default value is determined according to CIR-defaults at the interface level

### Requested incoming CIR

Specifies the requested incoming CIR.

**Valid Values:** The CIR can be either 0 or a value in the range 300 bps to 2 048 000 bps.

**Note:** The valid values for a FR interface on a HSSI adapter are: 0 or 300 - 52 000 000

**Default Value:** Value of the **requested outgoing CIR**

### Minimum acceptable incoming Committed Information Rate (CIR)

Specifies the minimum CIR that will be accepted if the network cannot provide the requested CIR.

**Valid Values:** The CIR can be either 0 or a value in the range 300 bps to 2 048 000 bps with a maximum of the **requested incoming CIR**.

**Note:** The valid values for a FR interface on a HSSI adapter are: 0 or 300 - 52 000 000

**Default Value:** Same as **minimum acceptable outgoing CIR**

### Requested outgoing committed burst size (Bc)

Specifies the requested outgoing committed burst size.

**Valid Values:** The CIR can be either 0 or a value in the range 300 bps to 2 048 000 bps.

**Note:** The valid values for a FR interface on a HSSI adapter are: 0 or 300 - 52 000 000

**Default Value:** Value determined according to CIR-defaults at the interface level

### Requested incoming committed burst size (Bc)

Specifies the requested incoming committed burst size.

**Valid Values:** The CIR can be either 0, or a value in the range 300 bps to 2 048 000 bps.

**Note:** The valid values for a FR interface on a HSSI adapter are: 0 or 300 - 52 000 000

**Default Value:** Value equal to **requested outgoing Bc**

## Configuring Frame Relay Interfaces (Talk 6)

### **Outgoing excess burst size (Be)**

Specifies the requested outgoing burst size.

**Valid Values:** The CIR can be either 0, or a value in the range 300 bps to 2 048 000 bps.

**Note:** The valid values for a FR interface on a HSSI adapter are: 0 or 300 - 52 000 000

**Default Value:** Value determined according to CIR-defaults at the interface level

### **Requested incoming excess burst size (Be)**

Specifies the requested incoming excess burst size.

**Valid Values:** The CIR can be either 0, or a value in the range 300 bps to 2 048 000 bps.

**Note:** The valid values for a FR interface on a HSSI adapter are: 0 or 300 - 52 000 000

**Default Value:** Same as **requested outgoing excess burst size (Be)**

### **Idle timer**

Specifies the time period that a SVC will remain active in the absence of traffic. Specifying 0 designates this SVC as a fixed circuit that will be established the first time data arrives for it and will not be disconnected even if no traffic flows over it.

**Valid Values:** 0 to 65535 seconds

**Default Value:** 60

### **Establish circuit to learn remote protocol addresses**

Specifies whether this SVC should be established when the interface comes up to learn the protocol addresses of the adjacent node. This option can be used in place of statically configured destination protocol names and addresses for protocols that support dynamic address discovery, such as IP, IPX, Appletalk2, and DECnet IV to force the router to learn the protocol addresses associated with the remote device via directed InARP. Using this option may help reduce ARP broadcasts. The idle timer will be used to disconnect the SVC once the protocol addresses are learned.

**Valid Values:** yes or no

**Default Value:** yes

### **Is multicast required for this circuit**

Specifies whether or not this SVC should be used to transmit multicast packets on this interface even if it means setting the SVC up just to do so. You may use static routes to keep from requiring multicast over SVCs so that the SVCs will not be established just to exchange routing information.

**Valid Values:** yes or no

**Default Value:** Defaults according to the multicast emulation setting at the interface level

## Configuring Frame Relay Interfaces (Talk 6)

### Are call-ins allowed

Specifies whether or not a call-in from this remote DTE should be accepted. Specifying no can be used to block call-ins from specific users and help eliminate call-in/call-out race conditions.

**Valid Values:** yes or no

**Default Value:** yes

### Compression capable

Specifies whether Frame Relay compression is supported.

**Valid Values:** yes or no

**Default Value:** yes, if compression is enabled for the interface. Otherwise, no.

### Encryption capable

Enables you to specify whether or not the circuit will encrypt data packets. This question appears only if encryption is enabled on the interface. The prompts for the encryption key and algorithm will appear only if you activate encryption on the SVC.

**Specifying the Encryption Key:** You must specify the encryption key value in hexadecimal characters.

**Valid Values:** 16 for CDMF, 48 for 3DES

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

## Change

Use the **change permanent-virtual-circuit** command to change any previous PVCs that were added with the **add permanent-virtual-circuit** command. If you use end-to-end type fragmentation, use the **change permanent-virtual-circuit** command to designate the PVCs over which end-to-end fragmentation will take place.

### Syntax:

```
change                frame-handler-pvc . . .  
                        permanent-virtual-circuit . . .  
                        switched-virtual-circuit . . .
```

### Example:

```
change permanent-virtual-circuit  
Circuit Number [16]?  
Committed Information Rate in bps [64000]?  
Committed Burst Size (Bc) in bits [64000]?  
Excess Burst Size (Be) in bits [0]?  
Assign Circuit Name: []?  
Is the circuit required for interface operation [N]?  
Does the circuit belong to a required PVC group [N]?  
Do you want to have data compression performed [Y]?  
Do you want end-to-end fragmentation performed on this circuit [Y]?  
Fragment size (50 to 8190) [256]?  
Fragmented packet reassembly timer (3 to 10 seconds) [3]?  
Do you want to have data encryption performed [N]?  
Enable circuit for voice forwarding [N]?
```

### frame-handler-pvc

## Configuring Frame Relay Interfaces (Talk 6)

See the **add frame-handler-pvc** command on page 526 for a description of the parameters.

### permanent virtual circuit

See the **add permanent-virtual-circuit** command on page 527 for a description of the parameters, except for the fragmentation parameters. These are described at the **enable fragmentation** command.

### switched-virtual-circuit

```
FR 4 Config>change switched-virtual-circuit
Circuit name []? svc01
Remote party number []? 12345
Remote party number numbering plan (E.164 or X.121) [E.164]?
Remote party number type (Unknown or International) [International]?
Remote party subaddress in hexadecimal []? 01
Remote party subaddress format (private or NSAP) [private]1?
Requested outgoing Committed Information Rate (CIR) in bps [64000]?
Minimum acceptable outgoing Committed Information Rate (CIR) in bps [64000]?
Requested incoming Committed Information Rate (CIR) in bps [64000]?
Minimum acceptable incoming Committed Information Rate (CIR) in bps [64000]?
Requested outgoing Committed Burst size (Bc) in bits [64000]?
Requested incoming Committed Burst size (Bc) in bits [64000]?
Requested outgoing Excess Burst size (Be) in bits [0]?
Requested incoming Excess Burst size (Be) in bits [0]?
Idle timer in seconds [60]?
Establish circuit to learn remote protocol addresses [Y]?
Is multicast required for this circuit [Y]?
Are call-ins allowed for this circuit [Y]?
```

See page 531 for a description of the parameters.

## Disable

Use the **disable** command to disable those features previously enabled using the **enable** command.

### Syntax:

```
disable                cir-monitor
                        cllm
                        compression
                        congestion-monitor
                        dn-length-field
                        encryption
                        fragmentation
                        lmi
                        lower-dtr
                        multicast-emulation
                        no-pvc
                        notify-fecn-source
                        orphan-circuits
                        point-to-point
                        protocol-broadcast
                        switched-virtual-circuits
```

## Configuring Frame Relay Interfaces (Talk 6)

`throttle-transmit-on-fecn`

**Note:** The parameters in the following list can be enabled and disabled on an FR subinterface:

- `dn-length-field`
- `multicast-emulation`
- `no-pvc`
- `point-to-point`
- `protocol-broadcast`

These parameters can have different values on an FR subinterface than they do on the FR base interface.

The remaining parameters can be disabled and enabled only on the FR base interface. The values of these parameters on the FR subinterfaces are determined by their values on the FR base interface. For example, if encryption is disabled on the FR base interface, it is disabled on all FR subinterfaces that are associated with that base interface.

### **cir-monitor**

Disabling this feature allows the circuit's information rate to exceed the maximum information rate that is calculated using the parameters configured with the **add permanent-virtual-circuit** or **add switched-virtual-circuit** command. The default setting for this feature is disabled. See "Circuit Congestion" on page 511 for more information.

**cllm** Disables the device from *throttling down* in response to a CLLM message. The default is disabled. See "Circuit Congestion" on page 511 for details.

### **compression**

Disables compression on the interface. Compression will not be performed for any VC. FR subinterfaces associated with the FR base interface will have the same value for compression as the base interface.

### **congestion-monitor**

Disables the congestion monitoring feature. Disabling this feature prevents a circuit's information rate from varying in response to congestion between the minimum information rate and the line speed. See "Circuit Congestion" on page 511 for more information. The default setting for this feature is enabled.

### **dn-length-field**

Prevents inter-operation with implementations of DECnet Phase IV over Frame Relay that require a length field to precede DECnet packets in Frame Relay frames, but allows inter-operation with DECnet Phase IV Frame Relay software that does not use a length field before the DECnet packet. Disabling `dn-length-field` causes Frame Relay not to insert a length field into transmitted frames containing DECnet packets and not to attempt to remove the length field from received frames containing DECnet packets.

**Note:** This option is presented as a configuration option only when the router software contains the DECnet Phase IV protocol. This option can be set on an FR subinterface and can differ from the value on the FR base interface.

### **encryption**

Disables encryption on the interface. Even though the PVCs on this interface may be encryption capable, encryption will not take place.

## Configuring Frame Relay Interfaces (Talk 6)

Encryption cannot be disabled or enabled for FR subinterfaces. FR subinterfaces will have the same value for encryption as the FR base interface.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### fragmentation

Globally disables fragmentation for this interface. FR subinterfaces will have the same value for fragmentation as the FR base interface.

**Imi** Disabling this parameter allows for normal operation or end-to-end Frame Relay testing in the absence of a real network or management interface. With end-to-end Frame Relay testing, it is necessary to add like PVCs (the same PVC number, such as 16 and 16) on both ends of the link. The associated Frame Relay subinterfaces will have the same value for this parameter as the Frame Relay base interface.

### lower-dtr

This parameter determines how the data terminal ready (DTR) signal is handled for leased serial-line interfaces on the router. It is not supported on Frame Relay dial circuit interfaces. See the **enable lower-dtr** command for a more complete description of the lower-dtr parameter.

The following cable types are supported:

- EIA 232 (RS-232)
- V.35
- V.36

The default setting is **disable lower-dtr**.

### multicast-emulation

Disables multicast emulation on each active VC. The default setting for this feature is *enabled*. If you disable this feature, you are required to add protocol static address maps. This option can be set on a FR subinterface and can differ from the setting on the FR base interface.

Some protocols, such as IPX RIP, will not function on the Frame Relay interface if multicast-emulation is disabled. The protocol-broadcast feature also requires multicast-emulation in order to function properly. For more information, see “Multicast Emulation and Protocol Broadcast” on page 506.

### no-pvc

Controls whether the interface is considered active or inactive. If no-pvc is disabled, the presence of active PVCs on the interface does not affect whether the Frame Relay interface is considered active or inactive. This option can be set on a FR subinterface and can differ from the setting on the FR base interface.

### notify-fecn-source

Disables setting a BECN bit on the first packet destined to a device from which the router received a packet with the FECN bit set. See “Circuit Congestion” on page 511 for more information.

### orphan-circuits

Prohibits the use of all non-configured PVC orphan circuits at the interface. The default setting for orphan circuits is enabled. Disabling orphan circuits adds a measure of security to your network by preventing unauthorized entry from a non-configured circuit. However, if you disable orphan circuits, you are required to add PVCs that will be used on the interface.



## Configuring Frame Relay Interfaces (Talk 6)

### **point-to-point**

Disables point-to-point on the interface. Point-to-point indicates that the interface is point-to-point from the perspective of IP. This option can be set on a FR subinterface and can differ from the setting on the FR base interface.

### **protocol-broadcast**

Prohibits protocols such as IP RIP from functioning over the Frame Relay interface. For more information, see “Multicast Emulation and Protocol Broadcast” on page 506. The default setting for this feature is enabled. This option can be set on a FR subinterface and can differ from the setting on the FR base interface.

### **switched-virtual-circuits**

Prohibits the use of SVCs.

### **throttle-transmit-on-fecn**

Prohibits the device from *throttling down* the transmission of packets in response to a packet with a FECN bit set on. The default is disabled. See “Circuit Congestion” on page 511 for more information.

## Enable

Use the **enable** command to enable Frame Relay features.

### **Syntax:**

<u>enable</u>	<u>cir-monitor</u>
	<u>cilm</u>
	<u>compression</u>
	<u>congestion-monitor</u>
	<u>dn-length-field</u>
	<u>encryption</u>
	<u>fragmentation</u>
	<u>lmi</u>
	<u>lower-dtr</u>
	<u>multicast-emulation</u>
	<u>notify-fecn-source</u>
	<u>no-pvc</u>
	<u>orphan-circuits</u>
	<u>point-to-point</u>
	<u>protocol-broadcast</u>
	<u>switched-virtual-circuits</u>
	<u>throttle-transmit-on-fecn</u>

**Note:** The parameters in the following list can be enabled and disabled on an FR subinterface:

- dn-length-field
- multicast-emulation
- no-pvc

## Configuring Frame Relay Interfaces (Talk 6)

- point-to-point
- protocol-broadcast

These parameters can have different values on an FR subinterface than they have on the FR base interface.

The remaining parameters can be disabled and enabled only on the FR base interface. The values of these parameters on the FR subinterfaces are determined by their values on the FR base interface. For example, if encryption is enabled on the FR base interface, it is enabled on all FR subinterfaces that are associated with that base interface.

### **cir-monitor**

Enables the circuit monitoring feature. The circuit monitoring feature ensures that the circuit's information rate varies between the minimum information rate and the maximum information rate, calculated using the parameters configured with the **add permanent-virtual-circuit** command or the **change permanent-virtual-circuit** command.

**Note:** The circuit monitoring feature overrides the congestion monitoring feature if there is a conflict when both are enabled. The default setting for this feature is disabled.

For additional information on CIR monitoring, see "CIR Monitoring" on page 511.

**Note:** To maximize throughput for circuits running data compression, you should not enable CIR monitoring on the same interface on which you have enabled compression. Because the device uses the uncompressed size of frames to determine if the VIR of a PVC is being exceeded and compressed frames will require less bandwidth, the CIR of a PVC will be under-utilized if the device strictly monitors and does not exceed the configured CIR. Instead, congestion monitoring can be used to allow the device to react to congestion indications sent by the FR network to avoid frame loss.

**cllm** Enables the device to *throttle down* in response to a CLLM message. Contact your FR network provider to see whether this support is available. See "Circuit Congestion" on page 511 for more information.

### **compression**

Enables compression on the interface. All compression-capable VCs on the interface can compress data packets, provided that contexts are available and the active compression circuit limit has not been exceeded. (See "Configuring and Monitoring Data Compression" in *Using and Configuring Features* for details.) FR subinterfaces associated with the FR base interface will have the same value for compression as the base interface.

**Note:** To maximize throughput for circuits running data compression, you should not enable CIR monitoring on the same interface on which you have enabled compression. Because the device uses the uncompressed size of frames to determine if the VIR of a VC is being exceeded and compressed frames will require less bandwidth, the CIR of a VC will be under-utilized if the device strictly monitors and does not exceed the configured CIR. Instead, congestion monitoring can be used to allow the device to react to congestion indications sent by the FR network to avoid frame loss.

## Configuring Frame Relay Interfaces (Talk 6)

### **congestion-monitor**

Enables the congestion monitoring feature. This feature allows a circuit's information rate to vary in response to congestion between the minimum information rate and the line speed.

**Note:** The circuit monitoring feature overrides the congestion monitoring feature if there is a conflict when both are enabled. The default setting for this feature is enabled.

For additional information on congestion monitoring, see "Congestion Monitoring" on page 512.

### **dn-length-field**

Supports inter-operation with implementations of DECnet Phase IV over Frame Relay that require a length field to precede DECnet packets in Frame Relay frames. Enabling dn-length-field causes Frame Relay to insert a length field into transmitted frames containing DECnet packets and to remove the length field from received frames containing DECnet packets. This option is disabled by default. By default, Frame Relay will neither insert nor attempt to remove the length field.

**Note:** This option is presented as a configuration option only when the router software contains the DECnet Phase IV protocol. This option can be disabled and enabled for FR subinterfaces and can differ from the value of the FR base net.

### **encryption**

Enables encryption on the interface. All VCs that are configured as encryption enabled, will encrypt all transmitted data.

FR subinterfaces associated with the FR base interface will have the same value for encryption as the base interface.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See "Load" on page 95.

**fragmentation** *fragmentation-type* *fragment-size* *fragmented packet-reassembly-timer* Enables fragmentation on an interface. Fragmentation on a circuit causes frames larger than the fragment size to be broken into smaller pieces and transmitted as separate frames. If end-to-end fragmentation is enabled, frames smaller than the fragment size will not be sent with a fragmentation header and can be interleaved between fragments of other frames. Fragmentation should be enabled for circuits that are either forwarding voice frames or communicating with another interface that is forwarding voice frames. Note however that fragmentation and interleaving can be done for any high priority data; that is, interleaving is supported for protocols other than voice over Frame Relay.

Keep in mind that you should configure the Bandwidth Reservation System (BRS) when you enable fragmentation to give priority to real-time traffic such as voice. For information on bandwidth reservation over Frame Relay, refer to "Using Bandwidth Reservation and Priority Queuing" and "Configuring and Monitoring Bandwidth Reservation" in *Using and Configuring Features*.

FR subinterfaces associated with the FR base interface will have the same value for fragmentation as the FR base interface.

## Configuring Frame Relay Interfaces (Talk 6)

### fragmentation-type

The values of this parameter are:

- User Network Interface (UNI)/ Network-to-Network Interface (NNI)
- End-to-end

User Network Interface (UNI)/Network-to-Network Interface (NNI) is the default type. UNI is DTE to DCE fragmentation; NNI is DCE to DCE fragmentation; and end-to-end is DCE to DCE fragmentation over particular specified PVCs within the interface.

When UNI/NNI fragmentation is enabled, fragmentation occurs for all circuits on the interface, including management PVCs, that is, DLCI 0. When you configure fragmentation over a PVC, the fragmentation type for that circuit is always end-to-end. You must enable end-to-end fragmentation for both ends of the PVC when fragmenting. The fragment size need not be the same in both directions, however.

If the path to the next router passes through a Frame Relay switch, you should use the end-to-end fragmentation type. If you use UNI/NNI connection from the 2216 to the next router, make sure that your Frame Relay network provider supports UNI/NNI fragmentation.

**Valid Values:** UNI/NNI, or end-to-end

**Default Value:** UNI/NNI

### fragment-size

Displays the fragment size of each fragment in bytes. For UNI/NNI fragmentation, this parameter specifies the fragment size used for all circuits on the interface. For end-to-end fragmentation, this parameter specifies the default fragment size for PVCs on this interface.

The fragment sizes are not negotiated and do not need to be the same on both sides of the PVC. However, the frame sent cannot be larger than the MTU of the receiving end of the PVC, regardless of the fragment size. If the frame exceeds the MTU of the receiving end, when the fragment arrives that overloads the receiver, the receiver will perform the following actions:

1. send an error message stating that it cannot buffer the fragment
2. discard that fragment
3. display the message *Out of sequence fragments*
4. eventually discard all the fragments of that frame

#### **Tips for Selecting the Fragment Size:**

- When you specify the fragment size, be sure that the fragment size is appropriate for the capacity of your link. The fragment size chosen should be based on the access rate and the amount of delay that is tolerable for any real-time data sharing the link.
- In addition, buffers on the router are allocated for each fragment. If the frame size is large and the fragment size very small, the router can allocate so many of its buffers to the fragments that the performance of the router itself is degraded.

**Valid Values:** 50 to 8190 bytes

## Configuring Frame Relay Interfaces (Talk 6)

**Default Value:** 256 bytes

### **fragmented-packet-reassembly-timer**

Displays the length of time in seconds that the receiver of the fragments waits for the next-in-sequence fragment to arrive. If this timer expires before the next fragment arrives, all the received fragments for that frame are discarded.

**Valid Values:** 3 to 10 seconds

**Default Value:** 3 seconds

**lmi** Enables management activity.

After issuing the **enable lmi** command, use the **set lmi-type** command to select the management mode for your Frame Relay interface. See “Enabling Frame Relay PVC Management” on page 522. The system defaults to ANSI T1.617 Annex D management.

Use the **enable lmi** command to resume LMI management if you have previously disabled Frame Relay management.

LMI only provides information about PVCs on an interface, so it does not need to be enabled if only SVCs are used unless it is required by the network. Q.922 determines the usability of all SVCs on an interface and is an indicator of the state of the interface itself. When both PVCs and SVCs are on an interface, LMI and Q.922 may be active at the same time.

LMI is a function that can be configured only on the FR base interface, not on FR subinterfaces.

### **lower-dtr**

This parameter determines how the data terminal ready (DTR) signal is handled for leased serial-line interfaces that are disabled. It is not supported on Frame Relay dial circuit interfaces. If this parameter is set to “disabled” (the default), the DTR signal will remain raised when the interface is disabled.

When lower-dtr is enabled, DTR will be lowered when the interface is disabled. This behavior may be desirable in situations where the interface has been configured as an alternate link for WAN Reroute and the interface is connected to a dial-out modem which maintains its dial connection based on the state of the DTR signal.

If this feature is enabled and the interface is disabled, the DTR signal is low and the modem keeps the dial connection down. When the interface is enabled, due to a WAN Reroute backup scenario, DTR is raised and the modem dials a stored number to the backup site. When the primary interface is restored, the alternate interface is disabled, DTR is lowered, and the modem hangs up the dial connection.

The following cable types are supported:

EIA 232 (RS-232)

V.35

V.36

The default setting is **disable lower-dtr**.

### **multicast-emulation**

Enables multicast emulation. This allows a multicast/broadcast frame to be transmitted on each active VC. This option can be set on a FR subinterface and can differ from the setting on the FR base interface.

## Configuring Frame Relay Interfaces (Talk 6)

Protocols such as ARP, IPX RIP, and IP RIP require multicast emulation to be enabled to function correctly over a Frame Relay interface. For more information, see “Multicast Emulation and Protocol Broadcast” on page 506. The default for this parameter is enabled.

### **no-pvc**

Controls whether the interface is considered active or inactive. When this feature is enabled, the Frame Relay interface becomes inactive when there are no active PVCs on the interface. If at least one PVC is active, the Frame Relay interface becomes active when a successful LMI exchange occurs between the router and the FR switch. This option can be set on a FR subinterface and can differ from the setting on the FR base interface.

### **notify-fecn-source**

Enables setting a BECN bit on the first packet destined to a device from which the router received a packet with the FECN bit set. Use this parameter to enhance the congestion control mechanisms of the device in a network whether the FR switches do not themselves set BECN but set FECN. See “Circuit Congestion” on page 511 for more information.

### **orphan-circuits**

Enables the use of all non-configured orphan circuits. The default for this feature is enabled. See “Orphan Permanent Virtual Circuit CIR” on page 509 for information about the default CIR values.

### **point-to-point**

Enables point-to-point on the interface. Point-to-point indicates that the interface is point-to-point from the perspective of IP. This option can be set on a FR subinterface and can differ from the setting on the FR base interface. Only one PVC or SVC can be defined on a point-to-point interface.

### **protocol-broadcast**

Allows protocols such as IP RIP to function correctly over the Frame Relay interface. The multicast emulation feature must be enabled for the protocol-broadcast feature to function correctly. The default setting for this feature is *enabled*. This option can be set on a FR subinterface and can differ from the setting on the FR base interface.

### **switched-virtual-circuits**

Allows the use of SVCs and prompts you for the local SVC network number, the numbering plan, whether call-ins from orphan SVCs are allowed, the number of dial-out retries performed for all SVCs on the interface, and whether network emulation mode, which is used in back-to-back (for example, dial circuit) router configurations, is required.

You can also use the **enable switched-virtual-circuits** command to change configured SVC interface parameters if SVCs have already been enabled.

#### **Example:**

```
FR 1 Config> enable switched
Local party number []? 4141990
Local party number numbering plan (E.164 or X.121) [E.164]?
Local party number type (Unknown or International) [International]?
Are call-ins allowed on this interface [Y]?
Call-out redial attempts [2]?
Network emulation mode [N]?
```

#### **Local party number**

Specifies the destination's Frame Relay address.

## Configuring Frame Relay Interfaces (Talk 6)

**Valid Values:** A 1 - 20 character string of decimal digits

**Default Value:** None

### Local party numbering plan

Specifies the format of the party number. The numbering plan must match that used by the FR network.

**Valid Values:** E.164 (ISDN) or X.121 (Data)

**Default Value:** E.164

### Local party number type

Specifies the destination Frame Relay party number type. The number type must match that used by the FR network.

**Valid Values:** International or Unknown

**Default Value:** International

### Call-ins allowed

Specifies whether calls from unconfigured (orphan) SVCs are allowed on this interface.

### Call-out redial attempts

Specifies the number of call-out redial attempts that will be performed for each SVC in case of a call-out timeout on this interface.

**Default Value:** 2

### Network emulation mode

Specifies whether this SVC is in network emulation mode. It is used for a back-to-back router configuration.

### throttle-transmit-on-fecn

Enables the device to *throttle down* the transmission of packets in response to a packet with a FECN bit set on. Use this parameter to minimize overall FR network congestion whenever a congestion indication is received. It causes the device to react to a FECN in the same way that it reacts to a BECN.

## List

Use the **list** command to display currently configured management and PVC information.

### Syntax:

```
list                               all
|                                     fragmentation-capable-pvcs
|                                     frame-handler-pvcs
|                                     hdlc
|                                     interface
|                                     lmi
|                                     permanent-virtual-circuits
|                                     protocol-addresses
|                                     pvc-groups
```



## Configuring Frame Relay Interfaces (Talk 6)

subinterfaces

switched-virtual-circuits

voice-forwarding-circuits

**all** Displays the Frame Relay configuration. The display is a combination of the **list hdlc**, the **list lmi**, **list switched-virtual-circuits**, and the **list permanent virtual circuits** commands.

### **fragmentation-capable-pvcs**

Displays all PVCs which are end-to-end fragment enabled along with their fragment size and reassembly timer values.

### **frame-handler-pvc**

Displays each frame handler PVC along with the routing partner for the specified net.

**hdlc** Displays the Frame Relay High-Level Data Link Control (HDLC) configuration.

### **Example for a FR base interface:**

```
list hdlc                               Frame Relay HDLC Configuration
Maximum frame size                       = 2048
Encoding                                 = NRZ
Idle state                               = Flag
Clocking                                 = External
Cable type                               = V.35 DTE
Line speed (bps)                         = 64000
Transmit delay                           = 0
Lower DTR                                = Enabled
```

### **Example for an FR subinterface:**

```
list hdlc interface                     Frame Relay Subinterface Configuration
Frame Relay base network number = 1
Emulate multicast                   = Yes   Protocol broadcast           = Yes
Point-to-point                       = Yes   Interface down if no PVCs       = No
```

### **Encoding**

The transmission encoding scheme for the serial interface. Encoding is NRZ (non-return to zero) or NRZI (non-return to zero inverted).

**Idle** The data link idle state: flag or mark.

### **Clocking**

The type of clocking: internal or external.

### **Cable type**

The serial adapter cable type: RS-232, V.35, V.36, or X.21.

### **Line Speed (bps)**

Indicates the physical data rate for the Frame Relay interface.

### **Maximum frame size**

Indicates the maximum frame size that can be transmitted or received over the network at any given time.

### **Transmit delay**

Indicates the number of additional flag bytes sent between frames.

### **Lower DTR**

Indicates whether the router will drop the DTR signal when a WAN Reroute alternate link is no longer needed. Dropping the DTR



## Configuring Frame Relay Interfaces (Talk 6)

signal causes the modem to terminate the leased-line connection for the alternate link. Lower DTR does not appear when the cable type is X.21.

### Emulate multicast

Indicates whether the multicast emulation feature is enabled on each active PVC, yes or no.

### Protocol broadcast

Indicates whether protocols such as IP RIP can function over the Frame Relay interface, yes or no.

### Point-to-point

Indicates whether interface is point-to-point from an IP perspective.

### Interface down if no PVCs

Indicates whether the router considers the interface unavailable when there are no active PVCs.

### Notes:

1. For a FR dial circuit interface, only the maximum frame size is displayed.
2. For FR interfaces on the HSSI adapter, the **list hdlc** command only displays a subset of the HDLC parameters shown above.

### interface

If the interface is an FR base interface, the same information is displayed as with the **list lmi** command. If the interface is an FR subinterface, the same information is displayed as with the **list hdlc interface** command.

**lmi** Displays logical management and related configuration information about the Frame Relay interface.

**Note:** For FR subinterfaces, this command displays the same information as the command **list hdlc**. FR subinterfaces do not support LMI management.

### Example:

```

Frame Relay Configuration
LMI network type      = UNI   LMI DLCI           = 0
LMI type              = ANSI  LMI Orphans OK      = Yes
CLLM enabled          = No    Timer Ty seconds    = 11
SVC network number    = 15
SVC Number type       = International
SVC Numbering plan    = E.164 SVC Call-out redial attempts = 2
SVC Call-ins allowed  = Yes   SVC Network emulation mode = No

Protocol broadcast    = Yes   Congestion monitoring   = Yes
Emulate multicast     = Yes   CIR monitoring          = No
Notify FECN source    = No    Throttle transmit on FECN = No
Point-to-point        = No

Data compression      = No

 1
Fragmentation Type = END-T0-END
Fragmentation Size = 440 Fragment reassembly timer = 3

Number VCs P1 allowed = 64   Interface down if no PVCs = No
Timer T1 seconds      = 10   Timer T2 seconds         = 15
LMI N1 increments     = 6    LMI N2 error threshold   = 3
LMI N3 error threshold = 4
MIR % of CIR           = 25   IR % Increment           = 12
IR % Decrement         = 25   DECnet length field      = No
Default CIR            = 64000 Default Burst Size       = 64000
Default Excess Burst   = 0
  
```

## Configuring Frame Relay Interfaces (Talk 6)

**1** The two lines that follow this marker appear only when fragmentation is on (yes).

### **LMI enabled**

Indicates whether the management features are enabled on the Frame Relay interface. If LMI is not enabled, this value is *no*; if LMI is enabled, the LMI network type, either UNI or NNI, is displayed.

### **LMI DLCI**

Indicates the management circuit number. This number reflects the LMI type: 0 for ANSI and ITU-T/CCITT and 1023 for REV1.

### **LMI Type**

Indicates the LMI type: REV1, ANSI, or CCITT.

### **LMI Orphans OK**

Indicates if non-configured circuits are available for use, yes or no.

### **CLLM Enabled**

Indicates whether CLLM is enabled on the Frame Relay interface.

### **Timer Ty seconds**

Indicates the amount of time that must elapse without the device receiving any CLLM messages or BECNs before the device considers a congestion condition cleared and gradually return the PVC to its configured transmission rate.

### **SVC network number**

Specifies the network number for the SVCs on this interface.

### **SVC number type**

Specifies the SVC number type, unknown or international.

### **SVC numbering plan**

Specifies whether the numbering plan is E.164 or X.121.

### **SVC call-out redial attempts**

Specifies the number of call-out redial attempts on this interface.

### **SVC network emulation mode**

Specifies whether this interface operates in network emulation mode for SVCs.

### **SVC call-ins allowed**

Specifies whether call-ins are allowed on this interface.

### **Protocol Broadcast**

Indicates whether protocols such as IP RIP can function over the Frame Relay interface, yes or no.

### **Emulate multicast**

Indicates whether the multicast emulation feature is enabled on each active PVC, yes or no.

### **Congestion Monitoring**

Indicates whether the congestion monitoring feature that responds to network congestion is enabled, yes or no.

### **CIR monitoring**

Indicates whether the circuit monitoring feature that enforces the transmission rate is enabled, yes or no.

## Configuring Frame Relay Interfaces (Talk 6)

### Notify FECN Source

Indicates whether this device sets a BECN bit on the first packet destined to a device from which the router received a packet with the FECN bit set.

### Throttle Transmit on FECN

Indicates whether the device will *throttle down* the transmission of packets in response to a packet with a FECN bit set on.

### Data compression

Indicates whether this interface has data compression enabled.

### Data encryption

Indicates whether this interface has data encryption enabled and the number of circuits that are encryption capable.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### Fragmentation

Indicates whether fragmentation is enabled on this interface.

### Fragmentation type

Displays the fragmentation type: UNI/NNI (User-to-Network interface/Network-to-Network interface), or end-to-end, which is fragmentation by peer DTEs over a specified PVC.

### Fragment size

Displays the fragment size of each fragment in bytes.

### Fragmentation timer value

Displays the length of time in seconds that the receiver of the fragments waits for the next fragment to arrive. If this timer expires before the next fragment arrives, all the received fragments for that frame are discarded.

### Orphan compression

Indicates whether orphan circuits on this interface will have data compression enabled.

**Note:** Enabling compression on orphan circuits will decrease the number of available compression contexts available for the native PVCs on the device.

Orphan compression applies to both PVCs and SVCs.

### Compression circuit limit

Indicates the maximum number of circuits that can participate in data compression.

### Number of compression VCs

Indicates the current number of VCs supporting data compression.

### P1 allowed

Indicates the aggregate total number of allowable PVCs and SVCs for use with this interface, including both the FR base interface and any subinterfaces associated with the base interface.

## Configuring Frame Relay Interfaces (Talk 6)

### Timer T1 seconds

Indicates the frequency with which the Frame Relay interface performs a sequence number exchange with the Frame Relay switch LMI entity.

### Counter N1 increments

Indicates the number of T1 timer intervals which must expire before a complete PVC LMI status enquiry is made.

### LMI N2 error threshold

Indicates the number of management event errors occurring within the N3 window that will cause a reset of the Frame Relay interface.

### LMI N3 error threshold window

Indicates the number of monitored management events used to measure the N2 error threshold.

### MIR % of CIR

Minimum IR, expressed as a percentage of CIR.

### IR % Increment

Percentage by which the router increments the IR each time it receives a frame without BECN until it reaches the maximum IR.

### IR % Decrement

Percentage by which the router decrements the IR each time it receives a frame that contains BECN until it reaches the minimum IR.

### Default CIR

The committed information rate, in bps, used as the default for VCs on this interface.

### Default Burst Size

The committed burst size, in bits, used as the default for VCs on this interface.

### Default Excess Burst Size

The excess burst size, in bits, used as the default for VCs on this interface.

### permanent-virtual-circuits

Displays all the configured PVCs on the Frame Relay interface.

#### Example:

```
FR 1 Config>list permanent virtual circuits
Maximum circuits allowable = 64
Circuits configured this interface = 2
PVCs configured this interface = 1
Total circuits configured = 4
Total PVCs configured = 2
```

Circuit Name	Circuit Number	Options	CIR in bps	Burst Size	Excess Burst
circ16	16	c	64000	64000	0

R = circuit is required  
G = circuit is required and belongs to a required PVC group  
F = circuit is fragmentation capable  
c = circuit is data compression capable  
d = circuit is CDMF data encryption capable  
t = circuit is triple-DES data encryption capable  
V = circuit is voice forwarding enabled  
H = frame handler circuit

## Configuring Frame Relay Interfaces (Talk 6)

### Maximum circuits allowable

Indicates the number of PVCs and SVCs that can exist for this interface, including the FR base interface and all subinterfaces that are associated with the FR base interface. This number includes any PVCs that you added with the **add permanent-virtual-circuit** command and any SVCs that you added with the **add switched-virtual-circuit** command and dynamically learned through the management interface.

### Circuits configured this interface

Indicates the number of currently configured PVCs and SVCs for this interface. This interface is either a FR base interface or a FR subinterface.

### PVCs configured this interface

Indicates the number of currently configured PVCs for this interface, either a FR base interface or a FR subinterface.

### Total circuits configured

Indicates the total number of currently configured PVCs and SVCs that exist for both the FR base interface and the subinterfaces.

### Total PVCs configured

Indicates the total number of currently configured PVCs that exist for both the FR base interface and the subinterfaces.

### Circuit Name

Indicates the ASCII designation of the configured PVC.

### Circuit Number

Indicates the DLCI of a currently configured PVC.

### Options

See the list of options at the lower part of the display for definitions.

### Committed Information Rate

Indicates the information rate at which the network agrees to transfer data under normal conditions.

### Committed Burst Size

The maximum amount of data in bits that the network agrees to deliver during a measurement interval equal to (Committed Burst Size/CIR) seconds.

### Excess Burst Size

The maximum amount of uncommitted data in bits in excess of Committed Burst Size that the network attempts to deliver during a measurement interval equal to (Committed Burst Size/CIR) seconds.

### protocol-addresses

Displays all the statically configured protocol addresses of circuit mappings at the Frame Relay interface.

#### Example:

```
list protocol-addresses
```

```
Frame Relay Protocol Address Translations
```

Protocol Type	Protocol Address	Circuit Number or Name
IP	125.2.29.4	21
IPX	000000004503	16

### Protocol Type

Displays the name of the protocol running over the interface.

## Configuring Frame Relay Interfaces (Talk 6)

### Protocol Address

Displays the protocol address of the device at the other end of the circuit.

### Circuit Number or Name

Displays the DLCI of the PVC or the name of the SVC that is handling the protocol.

### pvc-groups

Displays all the Required PVC groups on the Frame Relay interface.

#### Example:

```
list pvc-groups
  Required PVC group = group1

  Circuit # 16
```

### subinterfaces

Lists circuit information for all circuits, including those on FR base interfaces and FR subinterfaces. When the circuit is on the base net, this command displays the net number of the interface that the circuit is on and the word *base* in parentheses.

#### Example:

```
FR 1 Config>list subinterfaces
  Maximum circuits allowable = 64
  Circuits configured this interface = 2
  Total circuits configured = 4
```

Circuit Name	Circuit Number	Remote Party Number	Interface
circ16	16		1 (base)
circ17	17		4
svc1		998	1 (base)
svc2		998	4

### Maximum circuits allowable

Indicates the number of circuits that can exist for this interface, either the FR base interface or the FR subinterface.

### Circuits configured this interface

Indicates the number of currently configured PVCs and SVCs for this interface, either a FR base interface or a FR subinterface.

### Total circuits configured

Indicates the total number of circuits currently configured for both the FR base interface and the subinterfaces.

### switched-virtual-circuits

```
FR 0 Config>LIST SWITCHED-VIRTUAL-CIRCUITS
```

```
Maximum circuits allowable = 64
Circuits configured this interface = 2
SVCs configured this interface = 1
Total circuits configured = 5
```

Circuit Name	Options	Idle Timer		Outgoing Value	Incoming Value
SVC1	ILM c	60	CIR:	64000	64000
Remote party number: IE3445667			Min CIR:	64000	64000
Remote subaddress: Pc4456d			Burst:	64000	64000
			Excess:	0	0
svc1	ILM c	60	CIR:	64000	64000
Remote party number: IE3445666			Min CIR:	64000	64000
Remote subaddress: P344566			Burst:	64000	64000
			Excess:	0	0

Options: I - call-ins allowed, L - learn protocols, M - Multicast required  
c - compression capable, F - UNI/NNI fragmentation enabled

## Configuring Frame Relay Interfaces (Talk 6)

Address type: I - International, U - Unknown  
Numbering plan: E - E.164, X - X.121  
Subaddress format: N - NSAP, P - private

### Maximum circuits allowable

Indicates the number of circuits that can exist for this interface, either the FR base interface or the FR subinterface.

### Circuits configured this interface

Indicates the number of currently configured PVCs and SVCs for this interface, either a FR base interface or a FR subinterface.

### SVCs configured this interface

Indicates the number of currently configured SVCs for this interface, either a FR base interface or a FR subinterface.

### Total circuits configured

Indicates the total number of circuits currently configured for both the FR base interface and the subinterfaces.

### Circuit Name

Indicates the ASCII designation of the configured circuit.

### Committed Information Rate

Indicates the information rate at which the network agrees to transfer data under normal conditions.

### Committed Burst Size

The maximum amount of data in bits that the network agrees to deliver during a measurement interval equal to (Committed Burst Size/CIR) seconds.

### Excess Burst Size

The maximum amount of uncommitted data in bits in excess of Committed Burst Size that the network attempts to deliver during a measurement interval equal to (Committed Burst Size/CIR) seconds.

### Idle Timer

Time period that the SVC will remain active in the absence of traffic.

### Options

Indicates the options configured for the circuit.

### Remote party number

Remote destination FR address. This address is prefixed by the address type and numbering plan used.

### Remote subaddress

Remote party subaddress assigned to this connection. The subaddress is prefixed by the subaddress format.

### voice-forwarding-circuits

```
FR 2 Config>list voice
```

Circuit Name	Circuit Number	Forwarding Network	Forwarding Circuit
-----	-----	-----	-----
circ11	17	0	16

### Circuit Name

Indicates the ASCII designation of the configured circuit.

## Configuring Frame Relay Interfaces (Talk 6)

### Circuit Number

Indicates the circuit for this PVC.

### Forwarding Network

Indicates the net number to which this circuit forwards voice frames.

### Forwarding Circuit

Indicates the circuit number to which this circuit forwards voice frames.

## LLC

Use the **LLC** command to access the LLC configuration environment. See “LLC Configuration Commands” on page 233 for an explanation of each of these commands.

**Note:** The **LLC** command is supported only if APPN is in the software load.

### Syntax:

#### llc

## Remove

Use the **remove** command to delete any PVC, Required PVC group, frame-handler-pvc, or protocol-address previously added using the **add** command.

### Syntax:

```
remove                frame-handler-pvc . . .  
                        permanent-virtual-circuit . . .  
                        protocol-address  
                        pvc-group  
                        switched-virtual-circuit circuit-name
```

**frame-handler-pvc** *pvc#*

**permanent-virtual-circuit** *pvc#*

Deletes any configured PVC in the range 16 to 1007.

### Notes:

1. When you delete a PVC that is running compression, the interface decreases the count of active compression PVCs. If this action brings the count of compression PVCs below the limit, you will receive a message to that effect.
2. When you delete a PVC that is running encryption, the interface decreases the count of active encryption PVCs.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See the CONFIG process **load** command in *Nways Multiprotocol Access Services Software User's Guide*.

The use of multiple encryption (using encryption at both the IP Security Layer and at the Frame Relay or PPP data-Link Layer) within the router is restricted by U.S.A. Government export



## Configuring Frame Relay Interfaces (Talk 6)

regulations. It is only supported in software loads that are under strict export control (software loads that support RC4 with 128 bit keys and Triple DES).

### protocol-address

Deletes any configured protocol addresses (static ARP entries). This parameter prompts you for different information depending on the type of protocol that you are adding.

#### Example:

```
remove protocol-address  
Protocol name or number [IP]?
```

#### IP protocol:

```
IP Address [0.0.0.0]?  
Circuit Name or Number [16]?
```

#### IPX protocol:

```
Host Number (in hex)[]?  
Circuit Name or Number [16]?
```

#### AppleTalk Phase 2 protocol:

```
Network Number (1-65279) []?  
Node Number (1-253) []?  
Circuit Name or Number [16]?
```

#### DN protocol:

```
Node address [0.0]?  
Circuit Name or Number [16]?
```

#### Protocol name or number

Defines the name or number of the protocol that you are deleting. If you try to delete an unsupported protocol the system will display the error message:

```
Unknown protocol name, try again
```

To see a list of supported protocols, type ? at the Protocol name or number [IP]? prompt.

#### IP Address

Defines the 32-bit internet address of the remote IP host in dotted-decimal notation.

#### Host Number

Defines the 48-bit node address of the remote IPX host.

#### Network Number

Defines the AppleTalk Phase 2 network number.

#### Node Number

Defines the node number of the interface attached to the remote AppleTalk host.

#### Node address

Defines the DECnet node address of the remote DECnet host. Configure the node address in the format x,y, where x is a 6-bit area address and y is a 10-bit node number.

#### Circuit Number

Defines the name of a PVC or SVC that the protocol runs over.

## Configuring Frame Relay Interfaces (Talk 6)

### **pvc-group** *groupname*

Deletes any configured PVC group by name. The group is removed only if it has no member circuits.

**Example: remove pvc-group PVC group name [IP]?**

### **switched-virtual-circuit**

Deletes any configured SVC by circuit name.

## Set

Use the **set** command to configure the interface to run the Frame Relay protocol.

**Note:** The Talk 6 **set** command is not applicable for FR subinterfaces.

### **Set Command Considerations**

Two parameters, the n2-parameter and the n3-parameter, require further explanation before you configure them. The n2-parameter sets the error threshold for management events, and the n3-parameter sets the number of events that are monitored in the event window. If the number of management errors in the event window equals n2, the Frame Relay interface resets. For example:

**set n3-parameter 4**

**set n2-parameter 3**

You now have a window size of 4 (n3 = 4) and an error threshold of 3 (n2 = 3). That means the system is monitoring 4 management events and checking to determine if any of those are in error. If the number of events in error equals 3 (the n2 parameter), the Frame Relay interface is reset and the status of the network is considered *network down*.

For the status of the network to be considered *network up*, the number of events in error within the window must be less than n2 prior to any change in status.

### **Syntax:**

**set** cable\*  
cir-defaults  
clocking\*  
crc-type\*  
encoding\*  
frame-size  
idle . . .\*  
ir-adjustment . . .  
line-speed\*  
lmi-network-type  
lmi-type  
n1-parameter  
n2-parameter  
n3-parameter

## Configuring Frame Relay Interfaces (Talk 6)

p1-parameter

redials

t1-parameter

t2-parameter

transmit-delay . . . \*

ty-parameter

\* **Note:** The commands with an \* following them are not available for FR dial circuit interfaces.

**cable** *physical-interface-link-type data-connection-type*

Sets the cable type for the network physical link.

A DTE cable is used when you are attaching the router to some type of DCE device (for example, a modem or a DSU/CSU). A DCE cable is used when the router is acting as the DCE and providing the clocking for direct attachment.

The available options are:

Physical Interface Link Type	Data Connection Type
EIA 232 (RS-232)	DTE, DCE
V35	DTE, DCE
V36	DTE, DCE
X21	DTE, DCE
HSSI	DTE, DCE (see note)

**Note:** When a HSSI DCE cable is used, the other device must also be configured to use a HSSI DCE cable.

### cir-defaults

Sets the default values for the circuit congestion parameters. The parameters are:

**cir** Sets the default value of *cir* to the value provided by a Frame Relay network provider.

**Valid Values:** 0 or 300 to 204 800 bps

**Default Value:** 64 000

For HSSI, the maximum value that can be configured is 52 000 000 bps.

**bc** Sets the default value of *bc* to the value provided by a Frame Relay network provider.

**Valid Values:** See “Committed Burst (Bc) Size” on page 509

**Default Value:** 64 000

For HSSI, the maximum value that can be configured is 52 000 000 bps.

**be** Sets the default value of *be* to the value provided by a Frame Relay network provider.

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**Valid Values:** See “Excess Burst (Be) Size” on page 509

**Default Value:** 0

For HSSI, the maximum value that can be configured is 52 000 000 bps.

### Example:

```
FR 6 config> set cir-default
Default Committed Information Rate (CIR) in bps [64000]? 48000
Default Committed Burst Size (Bc) in bits [64000]? 40000
Default Excess Burst Size (Be) in bits [0]? 52000
```

### clocking [external or internal]

To connect to a modem or DSU, configure external clocking and select the appropriate DTE cable with the **set cable** command. Use the **set line-speed** command to configure the line speed.

To connect directly to another DTE device, configure internal clocking, select the appropriate DCE cable with the **set cable** command, and configure the clocking/line speed with the **set line-speed** command.

**Default:** external

**Note:** The clocking type is not configurable when Frame Relay is configured on a HSSI adapter. The clocking type is determined by the cable type. Internal clocking is used when the HSSI DCE cable type is configured and external clocking is used when the HSSI DTE cable type is configured.

### crc-type [crc-ccitt-16 or crc-ccitt-32]

CRC type can be configured as either 16-bit CRC or 32-bit CRC. The default is **crc-ccitt-16**.

**Note:** CRC type can only be configured for a FR interface on a HSSI adapter.

### encoding [NRZ or NRZI]

Sets the HDLC transmission encoding scheme as NRZ (non-return to zero) or NRZI (non-return to zero inverted). Most configurations use NRZ, which is the default.

**Note:** Encoding is set to NRZ for a FR interface on a HSSI adapter and is not configurable.

### frame-size #

Sets the maximum size of the network layer portion of the frames transmitted and received on the interface. This maximum size includes the 2-byte DLCI address and the user data shown in figure 39-4. The size you configure must be consistent with the maximum frame size supported by the Frame Relay switch and by the other FR DTEs in the Frame Relay network. Values are 262 to 8190. The default is 2048. Since the configured frame size includes the DLCI address and the FR RFC 1490 and RFC 2427 multi-protocol encapsulation header, the maximum protocol packet size that can be transmitted is less than the configured frame size and is protocol dependent. The following table shows how many bytes to subtract from the configured frame size to determine the maximum protocol packet size that can be transmitted and received on the interface.

IP

4 bytes

## Configuring Frame Relay Interfaces (Talk 6)

IPX	10 bytes
Appletalk Phase 2	10 bytes
DECnet Phase IV (DNA IV)	12 bytes
Banyan Vines	10 bytes
OSI	10 bytes
Bridging	10 bytes
APPN	58 bytes (see note)

**Note:** Assumes worst case for APPN BAN where a T/R MAC address header and LLC header are added in addition to the FR header bytes.

If FR data encryption is enabled then you must subtract up to an additional 12 bytes.

When using Frame Relay SVCs, the maximum information field size must be the same at both ends of the virtual circuit. To determine the maximum information field size, subtract 16 bytes from the frame size if encryption is enabled on the SVC and subtract 4 bytes if encryption is not enabled on the SVC.

### **idle [flag or mark]**

Sets the transmit idle state for HDLC framing. The default value is **flag**, which provides continuous flags (7E hex) between frames. The mark option puts the line in a marking state (OFF, 1) between frames.

**Note:** Idle is set to **flag** for a FR interface on a HSSI adapter and is not configurable.

### **ir-adjustment** *increment-% decrement-% minimum-IR*

Sets the minimum information rate (IR) and the percentages for incrementing and decrementing the IR in response to network congestion.

The minimum IR, expressed as a percentage of CIR, is the lower limit of the information rate. The minimum percentage is 1 and the maximum percentage is 100. The default is 25.

When network congestion clears, the information rate is gradually incremented by the IR adjustment increment percentage until the maximum information rate is reached. The minimum percentage is 1 and the maximum percentage is 100. The default is 12.

When network congestion occurs, the information rate is decremented by the IR adjustment decrement percentage each time a frame containing BECN is received until the minimum information rate is reached. The minimum percentage is 1, and the maximum percentage is 100. The default is 25.

### **Example:**

```
set ir-adjustment
IR adjustment % increment [12]?
IR adjustment % decrement [25]?
Minimum IR as % of CIR [25]?
```

### **line-speed** *rate*

For internal clocking, use this command to specify the speed of the transmit and receive clock lines.

For external clocking, this command does not affect the operation of the WAN/serial line but it does set the speed that some protocols, such as IPX,

## Configuring Frame Relay Interfaces (Talk 6)

use to determine routing cost parameters. You should set the speed to match the actual line speed. If the speed is not configured, the protocols assume a speed of 1 000 000 bps.

### Valid Values:

Internal Clocking: See Table 72

External Clocking: See Table 73

Table 72. Line Speeds When Internal Clocking is Used for 2216 Interfaces

Adapter Type	Speed Range
8-port EIA 232	9600 to 64 000 bps
6-port V.35/V.36	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps
8-port X.21	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps
1-port HSSI	22 368 000 bps or 44 736 000 bps

Table 73. Line Speeds When External Clocking is Used for 2216 Interfaces

Adapter Type	Speed Range
8-port EIA 232	2400 to 64 000 bps
6-port V.35/V.36	2400 to 2 048 000 bps
8-port X.21	2400 to 2 048 000 bps
1-port HSSI	1 544 000 bps to 52 000 000 bps

### lmi-network-type

Specifies how the interface operates with respect to LMI.

**Note:** The LMI network type must be compatible with the adjacent FR node. For example, if the adjacent node is configured as UNI, this FR interface must be configured with a LMI network type of NUI, and when using the NNI support both this interface and the adjacent FR node's interface must be using a LMI network type of NNI.

### Valid Values:

- UNI - user-to-network interface
- NUI - network-to-user interface
- NNI - network-to-network interface

**Default Value:** UNI

### lmi-type [rev1 or ansi or ccitt]

Sets the management type for the interface. See "Enabling Frame Relay PVC Management" on page 522 for details on setting Frame Relay management. The default is type **ansi** enabled.

Table 74. Frame Relay Management Options

Command	Management Type	Description
set	lmi-type rev1	Conforms to LMI Revision 1, (Stratocom's Frame Relay Interface Specification)
set	lmi-type ansi	Conforms to ANSI T1.617 ISDN-DSS1-Signalling Specification for Frame Relay Bearer Service (known as Annex D)

## Configuring Frame Relay Interfaces (Talk 6)

Table 74. Frame Relay Management Options (continued)

Command	Management Type	Description
set	lmi-type ccitt	Conforms to Annex A of ITU-T/CCITT Recommendation Q.933 - DSS1 Signalling Specification for Frame Mode Basic Call Control.

### **n1-parameter** *count*

Configures the number of T1 timer intervals that must expire before a complete PVC status enquiry is made. *Count* is the interval in the range 1 to 255. The default is 6.

### **n2-parameter** *max#*

Configures the number of errors that can occur in the management event window monitored by the n3-parameter before the Frame Relay interface resets. *Max#* is a number in the range 1 to 10. The default is 3. This parameter must be less than or equal to the n3-parameter or you will receive an error message.

### **n3-parameter** *max#*

Configures the number of monitored management events for measuring the n2-parameter. *Max#* is a number in the range 1 to 10. The default is 4.

### **p1-parameter** *max#*

Configures the maximum number of PVCs supported by the Frame Relay interface. This includes active, inactive, removed, and congested PVCs. *Max#* is a number in the range 0 to 992. The default is 64. 0 (zero) implies that the interface supports no PVCs.

### **t1-parameter** *time*

Configures the interval (in seconds) between sequence number exchanges with Frame Relay management. The management's T2 timer is the allowable interval for an end station to request a sequence number exchange with the manager. The T1 interval must be less than the T2 interval of the network. *Time* is a number in the range 5 to 30. The default is 10.

### **t2-parameter** *time*

Specifies the amount of time FR waits for an LMI status inquiry to be received before deciding that an error has occurred, if this interface is configured with an LMI network type of either NUI or NNI. The t2 interval must be less than the adjacent FR node's t1 timer. The value is a number in the range of 5 to 30 and the default is 15 seconds.

### **transmit-delay** *#*

Allows the insertion of a delay between transmitted packets. The purpose of this command is to slow the serial line so that it is compatible with older, slower serial devices at the other end. It can also prevent the loss of serial line hello packets between the lines. *#* is between 0 and 15 extra flags. The default is zero (0). Setting this parameter provides 0 to 15 extra flags between transmit frames. Table 75 on page 562 lists the units and range values for serial interfaces.

**Note:** If you configure a non-zero transmit delay for a FR interface on the 8-port EIA-232E adapter, 6-port V.35/V.36 adapter, or 8-port X.21 adapter, you must configure the line speed using the **set line-speed** command.

## Configuring Frame Relay Interfaces (Talk 6)

Table 75. Transmit Delay Units and Range for the 2216 Serial Interface

Unit	Minimum	Maximum
Extra Flags	0	15

### ty-parameter *time*

Configures the interval after which the device considers an existing congestion condition indicated by the receipt of a CLLM message to be cleared. If the device receives a CLLM message before the timer expires, the device resets this timer.

**Valid Values:** 5 to 30 seconds.

**Default Value:** 11 seconds.

---

## Accessing the Frame Relay Monitoring Prompt

To access the Frame Relay operating commands and to monitor Frame Relay on your router, perform the following steps:

1. At the OPCON prompt (\*), type **talk 5**.
2. At the GWCON prompt (+), enter the **interface** command to see a list of interfaces configured on the router.
3. Enter the **network** command followed by the network number of the frame relay interface. For example:

```
+ net 2
Frame Relay Monitoring
FR 2 >
```

---

## Frame Relay Monitoring Commands

This section summarizes and then explains the Frame Relay Monitoring commands. Use these commands to gather information from the database. Table 76 shows the commands.

Table 76. Frame Relay Monitoring Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Clear	Clears statistical information on the Frame Relay interface.
Disable	Disables CIR monitoring and congestion monitoring on the Frame Relay interface.
Enable	Enables CIR monitoring and congestion monitoring on the Frame Relay interface.
List	Displays statistics specific to the data-link layer and Frame Relay management.
LLC	Displays the LLC monitoring prompt.
Notrace	Disables packet tracing capability for individual circuits or for the entire interface.
Set	Sets CIR, Committed Burst Size, and Excess Burst Size for a Frame Relay VC.
Trace	Enables packet tracing capability for individual circuits or for the entire interface.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

**Note:** In this section, the terms *circuit number* and *PVC* are equivalent to the term *data link circuit identifier (DLCI)*.



## Clear

Use the **clear** command to zero statistical counters on the Frame Relay interface.

**Note:** Statistics can also be cleared by using the OPCODE **clear** command.

**Syntax:**

clear

## Disable

Use the **disable** command to disable the Frame Relay CIR monitoring and congestion monitoring features.

The **disable** command dynamically changes the router configuration. These changes will be lost when the router is restarted.

**Syntax:**

disable                                  cir-monitor  
    cllm  
    congestion-monitor  
    notify-fecn-source  
    throttle-transmit-on-fecn

## Enable

Use the **enable** command to enable the Frame Relay CIR monitoring and congestion monitoring features.

The **enable** command dynamically changes the router configuration. These changes will be lost when the router is restarted.

**Syntax:**

enable                                  cir-monitor  
    cllm  
    congestion-monitor  
    notify-fecn-source  
    throttle-transmit-on-fecn

## List

Use the **list** command to display statistics specific to the data-link layer and the Frame Relay interface.

**Syntax:**

list    all  
    circuit . . .  
    frame-handler-pvcs  
    interface  
    lmi

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permanent-virtual-circuits

pvc-groups

queues

subinterfaces

svcs

switched-virtual-circuit

virtual-circuits

voice-forwarding-circuits

**all** Displays circuit, management, and VC statistics on the Frame Relay interface. The output displayed for this command is a combination of the **list lmi** and **list permanent-virtual-circuit** commands.

**circuit** *name or number*

Displays detailed virtual circuit configuration and statistical information for the specified VC using the input circuit name or DLCI.

### Example:

```
list circuit 347
```

```
Circuit name = Valencia
```

```
Circuit state = Active Circuit is orphan = No
Frames transmitted = 0 Bytes transmitted = 0
Frames received = 0 Bytes received = 0
Total FECNs = 0 Total BECNs = 0
Times congested = 0 Times Inactive = 0
CIR in bits/second = 64000 Potential Info Rate = 56000
Committed Burst (BC) = 1200 Excess Burst (Be) = 54800
Minimum Info Rate = 16000 Maximum Info Rate = 64000
Required = Yes PVC group name = group1

Compression capable = Yes Operational = Yes
R-Rs received = 0 R-Rs transmitted = 0
R-As received = 0 R-As transmitted = 0
R-R mode discards = 0 Enlarged frames = 0
Decompress discards = 0 Compression errors = 0
Compression ratio = 1.72 to 1 Decompression ratio = 1.10 to 1

Fragmentation type = END-T0-END
Fragmentation Size = 0 Reassembly timer = 0
Fragments xmitted = 0 Fragments received = 0
Voice Frames xmitted = 0 Voice Frames rcv'd = 0

Encryption capable = Yes Operational = Yes
Encryption errors = 0 Decryption errors = 0
Rcv error discards = 0

Current number of xmit frames queued = 0
Xmit frames dropped due to queue overflow = 0
```

### Circuit state

Indicates the state of the circuit: inactive, active, or congested. Inactive indicates that the circuit is not available for traffic because either the Frame Relay interface is down or the Frame Relay management entity has not notified the Frame Relay protocol that the circuit is active. Active indicates that data is being transferred. Congested indicates that data flow is being controlled.

### Circuit is orphan

Indicates if the circuit is a non-configured PVC learned through LMI management or a callin-in for a non-configured SVC.

### Frames/Bytes transmitted

Indicates how many frames and bytes this VC has transmitted.

## Monitoring Frame Relay Interfaces

### Frames/Bytes received

Indicates how many frames and bytes this VC has received.

### Total FECNS

Indicates the number of times that this VC has been notified of inbound or downstream congestion.

### Total BECNS

Indicates the number of times that this VC has been notified of outbound or upstream congestion.

### Times congested

Indicates the number of times that this VC has become congested.

### Times inactive

Indicates the number of times that this VC was inoperable.

### CIR in bits/sec

Indicates the information rate of the VC within the range 300 bps to 2 048 000 bps. A value of 0 is also supported.

### Potential Info Rate

Indicates the current maximum rate in bps at which data will be transmitted for the circuit. The actual data rate will depend on the queue depths and priorities associated with the circuit.

If this field has a value of "Line Speed", then the maximum data rate is the actual line speed even if the line speed was not configured or was configured incorrectly for this interface.

### Committed Burst (Bc)

Maximum amount of data, in bits, that the router can transmit during the *time interval* (Tc). ( $Tc=Bc/CIR.$ )

### Excess Burst (Be)

Maximum amount of uncommitted data in bits the router can transmit on a VC in excess of the Bc during the time interval (Tc).

### Minimum Info Rate

Minimum Information Rate. The minimum data rate for a VC that the router throttles down to when it is notified of congestion.

### Maximum Info Rate

Maximum Information Rate. The maximum data rate at which the router transmits for a VC.

### Required

Yes or No. If yes, the PVC is a Required PVC.

### PVC group name

If the PVC is a member of a required PVC group, the name appears here; otherwise, "Unassigned" appears.

### Compression capable

Indicates whether the circuit can compress data packets.

### Operational

Indicates whether compression is active on the circuit. When this is yes, data is being compressed on this link.

### R-Rs received

Indicates the number of Reset-Request packets sent by the peer decompressor. A peer decompressor sends a Reset-Request

## Monitoring Frame Relay Interfaces

whenever the peer detects that it is out of synch with its peer compressor. If this number increases rapidly, packets are being lost or corrupted on this circuit.

### **R-Rs transmitted**

Indicates the number of Reset-Request packets sent since compression started on the circuit. If this number increases rapidly, packets are being lost or corrupted on this circuit.

### **R-As received**

Indicates the number of Reset-Acknowledgements received in response to Reset-Requests. The compressor also sends out this packet to signal that it has reset its compression history.

### **R-As transmitted**

This is the number of Reset-Acknowledgements sent to the peer.

### **R-R mode discards**

Indicates the number of compressed data frames that were discarded while waiting for an R-A after sending out an R-R.

### **Enlarged frames**

This is a count of the frames that could not be compressed. Usually an incompressible frame is sent in its uncompressed format within a special compression frame type allowing the compressor and decompressor to remain synchronized.

### **Decompress discards**

Indicates the number of compressed frames that were discarded because of decompression errors.

### **Compression errors**

Indicates the number of frames that had compression errors which were transmitted in an uncompressed form.

### **Compression ratio**

Indicates the approximate effectiveness of the compressor.

### **Decompression ratio**

Indicates the approximate effectiveness of the decompressor.

### **Fragmentation type**

Indicates the fragmentation type. The values are UNI/NNI and end-to-end. See the talk 6 **enable fragmentation** command for more information.

### **Fragmentation size**

Indicates the size of the fragment. See the talk 6 **enable fragmentation** command for more information.

**Note:** If end-to-end fragmentation is configured, the fragment size shows the size configured of the interface, not the size for every PVC.

### **Reassembly timer**

Indicates the time set on the fragmented packet reassembly timer. If the next-in-sequence fragment in a fragmented packet fails to arrive before this timer expires, the fragment is discarded when it arrives and all the fragments of that frame are dropped.

### **Encryption capable**

Indicates whether this circuit is encryption enabled.

## Monitoring Frame Relay Interfaces

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### Operational

Indicates whether encryption is active on the circuit. When this is yes, data is being encrypted on this link.

### Encryption errors

Indicates the number of frames that had encryption errors.

### Decryption errors

Indicates the number of frames that had decryption errors.

### Rcv error discards

Indicates the number of compressed frames that were discarded because of reception problems.

### Current number of xmit frames queued

Indicates the number of frames currently queued for this circuit by FR. These frames are waiting for space to become available on the serial device handler transmit queue for this interface.

### Xmit frames dropped due to queue overflow

Indicates the number of frames that could not be transmitted for this VC due to output queue overflow.

## frame-handler-pvcs

### Example:

Frame Relay Frame Handler Configuration

Circuit Name	Circuit Number	Status (L/R)	Forwarding Net/Circuit	Max Queue (L/R)
Raleigh	16	A/A	2/18	10/10

Sum of outbound queue limits = 10 Input buffers allocated = 24  
Total congested frms discard = 0 Total frms currently queued = 0  
Total BECNs set = 0 Total FECNs set = 0

Local/Remote circuit states: A - Active I - Inactive R - Removed

### Status (local/remote)

Indicates the state of this PVC (local), either active or inactive and the status of this FH PVC's partner circuit (remote).

### Forwarding Net/Circuit

Network number and circuit number of the forwarding PVC.

### Max Queue (local/remote)

The configured maximum queue length for this circuit (local) and his partner (remote).

### Sum of outbound queue limits

The aggregate of the queue limits for all FH PVCs on this interface. If this number is greater than the *Input buffers allocated* field, then input frames will be dropped before the outbound queue limit for all FH circuits can be reached. This occurs because the input buffers for this interface are queued for output on the outbound partner circuit.

### Input buffers allocated

The input buffers allocated for this interface.

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### Total congested frames discarded

The total number of frames discarded by this FH circuit due to either inbound or outbound congestion.

### Total frms currently queued

The total number of outbound frames currently queued for this circuit.

### Total BECNs set

The total number of times BECN was set in a frame due to congestion.

### Total FECNs set

The total number of times FECN was set in a frame due to congestion.

## interface

For an FR base interface, the **list interface** command displays the same information as the **list lmi** command. For an FR subinterface, this command displays the same information as the Talk 6 **list hdlc** command.

## lmi

Displays statistics relevant to the logical management on the Frame Relay interface. If you enter this command for an FR subinterface, the information for its FR base interface is displayed.

### Example:

```
list lmi
Management Status:
-----
LMI network type = UNI LMI DLCI = 0
LMI type = ANSI LMI Orphans OK = YES
CLLM enabled = No

SVC local net number = 12345678
SVC Number type = International
SVC Numbering plan = E.164 SVC Call-out retries = 2
SVC Call-ins allowed = Yes SVC Network emulation mode = No

Protocol broadcast = Yes Congestion monitoring = Yes
Emulate multicast = Yes CIR monitoring = No
Notify FECN source = No Throttle transmit on FECN = No
Number VCs P1 allowed = 64 Interface down if no PVCs = No
Line speed (bps) = 1000000 Maximum frame size (bytes) = 2048
Timer T1 seconds = 10 Counter N1 increments = 6
LMI N2 threshold = 3 LMI N3 threshold window = 4
MIR % of CIR = 25 IR % Increment = 12
IR % Decrement = 25 DECnet length field = No
Default CIR = 64000 Default Burst Size = 64000
  Default Excess Burst = 0
Current receive sequence = 0
Current transmit sequence = 1
Total status enquiries = 9 Total status responses = 0
Total sequence requests = 0 Total responses = 0

Data compression enabled = No
Data encryption enabled = No
Fragmentation enabled = No

Virtual Circuit Status:
-----
Total allowed = 64 Total configured = 2
Total active = 0 Total congested = 0
Total PVCs left net = 0 Total PVCs join net = 0
```

### Management Status:

#### LMI enabled

If Frame Relay management is not active, the value is *no*. If LMI is

## Monitoring Frame Relay Interfaces

active, this entry displays UNI, NUI, or NNI, depending upon the network interface being used by LMI.

### **LMI DLCI**

Indicates the management circuit number. This number is either 0 (ANSI default or ITU-T/CCITT) or 1023 (interim LMI REV1).

### **LMI type**

Indicates the type of frame relay management being used, ANSI, ITU-T/CCITT, or LMI Revision 1.

### **LMI orphans OK**

Indicates if all non-configured circuits learned from Frame Relay LMI management are available for use (yes or no).

### **CLLM enabled**

Specifies whether this circuit will throttle transmission on receiving CLLM frames.

### **Timer Ty seconds**

Indicates the value of the CLLM Ty timer. This field is only displayed if CLLM is enabled.

### **Last CLLM cause code**

Indicates the congestion cause code given in the last CLLM message received or **None** if no CLLM messages have been received. This field is only displayed if CLLM is enabled.

### **SVC local net number**

Specifies the network number for the SVCs on this interface.

### **SVC number type**

Specifies the SVC number type, unknown or international.

### **SVC numbering plan**

Specifies whether the numbering plan is E.164 or X.121.

### **SVC call-out retries**

Specifies the number of call-out redial attempts on this interface.

### **SVC network emulation mode**

Specifies whether this interface operates in network emulation mode for SVCs.

### **SVC call-ins allowed**

Specifies whether call-ins are allowed on this interface.

### **Protocol broadcast**

Indicates if protocols such as IP RIP are able to operate over the Frame Relay interface.

### **Congestion monitoring**

Indicates whether the congestion monitor feature that responds to network congestion is enabled (yes or no).

### **Emulate multicast**

Indicates whether the multicast emulation feature is enabled on each active PVC (yes or no).

### **CIR monitoring**

Indicates whether the circuit monitoring feature that enforces the transmission rate is enabled (yes or no).

## Monitoring Frame Relay Interfaces

### **PVCs P1 allowed**

Indicates the number of allowable VCs for use with this interface. This number is the maximum number of active, congested, inactive, and removed VCs that can be supported on the interface.

### **Interface down if no PVCs**

Indicates whether the router considers the interface unavailable when there are no active PVCs.

### **Line speed (bps)**

Indicates the configured data rate of the Frame Relay interface.

### **Timer T1 seconds**

Indicates the frequency with which the Frame Relay interface performs a sequence number exchange with the Frame Relay switch LMI entity.

### **Counter N1 increments**

Indicates the number of T1 timer intervals which must expire before a complete PVC LMI status enquiry is made.

### **LMI N2 error threshold**

Indicates the number of management event errors occurring within the N3 window that will cause a reset of the Frame Relay interface.

### **LMI N3 error threshold window**

Indicates the number of monitored management events used to measure the N2 error threshold.

### **MIR % of CIR**

Minimum IR, expressed as a percentage of CIR.

### **IR % Increment**

Percentage by which the router increments the IR each time it receives a frame without BECN until it reaches the maximum IR.

### **IR % Decrement**

Percentage by which the router decrements the IR each time it receives a frame that contains BECN until it reaches the minimum IR.

### **DECnet length field**

Indicates whether or not the DECnet length field feature is enabled. Some Frame Relay DECnet Phase IV implementations require a length field between the Frame Relay multiprotocol encapsulation header and the DECnet packet. A length field is inserted if the DECnet length field feature is enabled.

### **Default CIR**

Specifies the default CIR for this interface.

### **Default Burst Size**

Specifies the default burst size for this interface.

### **Default Excess CIR**

Specifies the default excess burst size for this interface.

### **Current receive sequence**

Indicates the current receive sequence number that the Frame Relay interface has received from the Frame Relay management entity.



## Monitoring Frame Relay Interfaces

### Current transmit sequence

Indicates the current transmit sequence number that the Frame Relay interface has sent to the Frame Relay management entity.

### Total status enquiries

Indicates the total number of status enquiries that the Frame Relay interface has made of the Frame Relay management entity.

### Total status responses

Indicates the total number of responses that the Frame Relay interface has received from the Frame Relay management entity in response to status enquiries.

### Total sequence requests

Indicates the total number of sequence number requests that the Frame Relay interface has sent to the Frame Relay management entity.

### Total responses

Indicates the total number of sequence number responses that the Frame Relay interface has received from the Frame Relay management entity.

### Data compression enabled

Indicates whether data compression is enabled on this interface.

### Data encryption enabled

Indicates whether data encryption is enabled on this interface.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### Fragmentation enabled

Indicates whether Frame Relay packet fragmentation is enabled on this interface.

### Fragmentation type

Displayed only when Frame Relay packet fragmentation is enabled on this interface.

### Orphan compression

Indicates whether orphan circuits on this interface will have data compression enabled.

**Note:** Enabling compression on orphan circuits will decrease the number of available compression contexts available for the native VCs on the device.

Orphan compression applies to both PVCs and SVCs.

### Compression circuit limit

Specifies the maximum number of VCs that can compress data on this interface.

### Active compression circuits

Specifies the number of VCs currently compressing data on this interface.

### Data encryption enabled

Indicates whether data encryption is enabled on this interface.

## Monitoring Frame Relay Interfaces

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### Active encryption circuits

Indicates the number of VCs that are currently encrypting data.

### Virtual Circuit Status:

- *Total allowed*—Indicates the number of allowable VCs (including orphans) whose state is active, congested, removed, or inactive for use with this interface.
- *Total configured*—Indicates the total number of currently configured VCs for this interface.
- *Total active*—Indicates the number of active VCs on this interface.
- *Total congested*—Indicates the number of VCs that are throttled down because of congestion within the network.
- *Total PVCs left net*—Indicates the total number of PVCs that have been removed from the network.
- *Total PVCs joined net*—Indicates the total number of PVCs that have been added to the network.

### permanent-virtual-circuit

Displays general link-layer statistics and configuration information for all configured PVCs on the Frame Relay interface.

#### Example:

```
FR 0>LIST PERMANENT-VIRTUAL-CIRCUITS
```

Circuit Number	Circuit Name	Options	Type/State	Frames Transmitted	Frames Received
16	Unassigned	R	P/I	0	0
17	Bigcir	F V	P/I	0	0
18	Unassigned		P/I	0	0

```
Circuit type: 0 - Orphan P - PVC S - SVC
Circuit state: A - Active I - Inactive R - Removed C - Congested
R - Required G - Required and belongs to a PVC group
F - circuit is fragmentation capable
c - Data compression capable but not operational
C - Data compression capable and operational
d - CDMF DES data encryption capable but not operational
D - CDMF DES data encryption capable and operational
t - 3DES data encryption capable but not operational
T - 3DES data encryption capable and operational
V - circuit is voice forwarding enabled
H - Frame Handler circuit
```

#### Circuit#

Indicates the DLCI of the PVC.

#### Circuit Name

Name of the circuit, an ASCII string.

#### Orphan Circuit

Indicates whether the PVC is a non-configured circuit (yes or no).

#### Type/State

Indicates the state of the circuit, A (active), I (inactive), P (permanent), C (congested), or R (removed).

#### Frames Transmitted

Indicates how many frames this PVC has transmitted.

## Monitoring Frame Relay Interfaces

### Frames Received

Indicates how many frames this PVC has received.

### pvc-groups

Displays required PVC group information for all required PVC groups. For each group this consists of the group name, the circuits in the group and the state (active, inactive, or removed) of each circuit.

#### Example:

```
list pvc-groups
Group name          Circuits in group  Circuit status
-----
group1              16                active
                   44                inactive
                   240               removed
```

### queues

Displays the counts of frames transmitted and received, the number of frames discarded, the current number of frames queued and the high queue count. The high queue count is the maximum number of frames that were ever queued for this circuit.

#### Example:

```
DLCI      Circuit Name          Frames Sent  Frames Rcv'd  Frames Discard  Frames Queued  High Queue
-----
18 Phoenix 11946        12041        2             41             41
```

### subinterfaces

Lists circuit information for all circuits, including those on FR base interfaces and FR subinterfaces. When the circuit is on the base net, this command displays the net number of the interface that the circuit is on and the word *base* in parentheses.

#### Example:

```
FR 1>list subinterfaces

Circuit Name      Circuit Number  Circuit Type  Interface Number
-----
svc1              16             Switched     1 (base)
circ16           16             Permanent    1 (base)
svc2              4             Switched     4
circ17           17             Permanent    4
```

**svcs** Displays all SVCs, either configured or orphaned, on the interface regardless of state.

#### Example:

```
FR 1>list svcs

Circuit Name      Remote party number  Circuit State  Call State  DLCI
-----
flotsam           911                 R             N             0
jetsam            666                 R             N             0
Circuit states: A - Active  I - Inactive  R - Removed  C - Congested
Call states: N - Null      I - Call Initiated  O - Outgoing call proceeding
A - Active  D - Disconnect request  R - Release request
```

### switched-virtual-circuit

The following example displays configuration and operational information for a single SVC by name.

#### Example:

## Monitoring Frame Relay Interfaces

```
FR 1>list switched-virtual-circuit flotsam
Circuit      Opt-   Idle      Outgoing   Incoming
Name         ions   Timer     Value      Value
-----
flotsam      ILMF   60        CIR:       0          0
Call state: Null
Call Initiated by: None    DLCI: 0    Burst:     0          0
Remote party number: IE14  Excess:   0          0
Remote subaddress: None

Options: I - call-ins allowed, L - learn protocols, M - multicast required
F - UNI/NNI fragmentation capable C - compression capable and operational
c - compression capable, d - CDMF DES data encryption capable but not operational
D - CDMF DES data encryption capable and operational t - 3DES data encryption
capable but not operational T - 3DES data encryption capable and operational
Address type: I - International, U - Unknown Numbering plan: E - E.164,
X - X.121 Subaddress format: N - NSAP, P - private
```

### virtual-circuits

Displays all PVCs and all active SVCs with associated information that is identical to the **list permanent-virtual-circuit** command.

```
FR 1>list virtual-circuits
```

Circuit Number	Circuit Name	Options	Type/State	Frames Transmitted	Frames Received
16	Unassigned	F	P/I	0	0
17	Unassigned	F H	P/I	0	0
23	To-Kitty	F H	P/I	0	0

```
Circuit type: 0 - Orphan P - PVC S - SVC
Circuit state: A - Active I - Inactive R - Removed C - Congested
R - Required G - Required and belongs to a PVC group
F - circuit is fragmentation capable
c - Data compression capable but not operational
C - Data compression capable and operational
d - CDMF DES data encryption capable but not operational
D - CDMF DES data encryption capable and operational
t - 3DES data encryption capable but not operational
T - 3DES data encryption capable and operational
V - circuit is voice forwarding enabled
```

### voice-forwarding-circuits

Displays all PVCs that have been defined as being capable of forwarding voice packets.

```
FR 2>list voice-forwarding-circuits
```

Circuit Name	Circuit Number	Forwarding Network	Forwarding Circuit
circ16	16	2	17
circ17	17	2	16

## LLC

Use the **LLC** command to access the LLC monitoring prompt. LLC commands are entered at this new prompt. See "LLC Monitoring Commands" on page 236 for an explanation of each of these commands.

### Syntax:

#### llc

**Note:** The LLC command is supported only if APPN is in the software load.

## Notrace

Use the **notrace** command to disable packet tracing for individual circuits or the entire interface. This command can be used as a filter when tracing specific circuits or interfaces is required. The default setting is to trace all circuits.

### Syntax:

```
notrace                circuit#
                        circuitname
                        all
```

### Example:

```
notrace 16
    Disables packet tracing on circuit (PVC or SVC) with DLCI 16.
notrace circuit phoenix
    Disables packet tracing on circuit (PVC or SVC) named phoenix.
notrace circuit all
    Disables packet tracing on all circuits on this interface.
```

## Set

Use the **set** command to set the values for Committed Information Rate (CIR), Committed Burst Rate, and Excess Burst Rate for the specified VC. You also can set values for IR adjustment rates.

Changes made with this command do not affect the configuration data. They are in effect only until the router is restarted.

### Syntax:

```
set                    circuit . . .
                        ir-adjustment . . .
```

**circuit** *circuit# or name cirval bcval beval*

Sets the values for Committed Information Rate (CIR), Committed Burst Rate, and Excess Burst Rate for the specified VC and can be used to change the operational outgoing CIR, Bc, and Be for a PVC or an active SVC.

### Example:

```
set circuit
Circuit number [16]?
Committed Information Rate (CIR) in bps [1200]?
Committed Burst Size (Bc) in bits [1200]?
Excess Burst Size (Be) in bits [56000]?
```

#### Circuit Number

Indicates the circuit number in the range 16 to 1007.

#### Committed Information Rate

Indicates the committed information rate (CIR). The CIR can be either 0, or a value in the range 300 bps to 2 048 000 bps. The default is 64 kbps. For more information, see “Committed Information Rate (CIR)” on page 508.

#### Committed Burst Size

The maximum amount of data in bits that the router will send during

## Monitoring Frame Relay Interfaces

a measurement interval equal to committed burst (Bc) size / CIR seconds. The range is 300 to 2 048 000 bits. The default value is 64 Kb.

**Note:** If CIR is configured as 0 then the committed burst size is set to 0 and you are not prompted for a value. For additional information, see “Committed Burst (Bc) Size” on page 509.

### Excess Burst Size

The maximum amount of uncommitted data in bits in excess of committed burst size that the router attempts to deliver during a measurement interval equal to (Committed Burst Size/CIR) seconds. Range is 0 to 2 048 000 bits. Default is 0. For additional information, see “Excess Burst (Be) Size” on page 509.

### **ir-adjustment** *increment-% decrement-% minimum-IR*

Sets the minimum information rate (IR) and the percentages for incrementing and decrementing the IR in response to network congestion.

**Note:** The Talk 5 **set ir-adjustment** command is not applicable for FR subinterfaces.

The minimum IR, expressed as a percentage of CIR, is the lower limit of the information rate. The minimum percentage is 1 and the maximum percentage is 100. The default is 25.

When network congestion clears, the information rate is gradually incremented by the IR adjustment increment percentage until the maximum information rate is reached. The minimum percentage is 1 and the maximum percentage is 100. The default is 12.

When network congestion occurs, the information rate is decremented by the IR adjustment decrement percentage each time a frame containing BECN is received until the minimum information rate is reached. The minimum percentage is 1, and the maximum percentage is 100. The default is 25.

### Example:

```
set ir-adjustment
  IR adjustment % increment [12]?
  IR adjustment % decrement [25]?
  Minimum IR as % of CIR [25]?
```

## Trace

Use the **Trace** command to enable packet tracing for individual circuits or the entire interface and to list the tracing capability of all circuits on this interface. This command can be used as a filter when tracing specific circuits or interfaces is required. The default setting is to trace all circuits.

### Syntax:

```
trace                all
                    circuitname
                    circuit#
                    list
```

**Example:**

```

trace 16
    Enables packet tracing on circuit (PVC or SVC) with DLCI 16.
trace circuit phoenix
    Enables packet tracing on circuit (PVC or SVC) named phoenix.
trace circuit all
    Enables packet tracing on all circuits on this interface.
  
```

```

trace list
The following circuits are available for packet trace
Circuit Name          Circuit Number
-----
Unassigned            16
phoenix               25
jetsam                0
  
```

Lists the packet tracing capability of all circuits on this interface.

### Frame Relay Interfaces and the GWCON Interface Command

While Frame Relay interfaces have a monitoring process for monitoring purposes, the router also displays complete statistics for installed interfaces when you use the **interface** command from the GWCON environment. (For more information on the **interface** command, refer to “Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands” on page 109)

### Statistics Displayed For Frame Relay Interfaces

Statistics similar to the following are displayed when you execute the **interface** command from the GWCON environment for Frame Relay interfaces. The actual display will vary somewhat depending upon the adapter type, for example, X.21, V.35, or HSSI.

If FR subinterfaces have been configured, the GWCON statistics and error commands for the FR base interface will display cumulative counts for all circuits on the FR base interface and all associated subinterfaces. For a subinterface, these commands will list counts for only the circuits defined for the subinterface.

```

+interface 10
Nt Nt' Interface Slot-Port          Self-Test Passed Self-Test Failed Maintenance Failed
10 10 FR/0      Slot: 8 Port: 0                2           1           0

  Frame Relay MAC/data-link on V.35/V.36 interface

  Adapter cable:          V.35 DTE

  V.24 circuit: 105 106 107 108 109
  Nicknames:    RTS CTS DSR DTR DCD
  PUB 41450:    CA CB CC CD CF
  State:        ON ON ON ON ON

  Line speed:          64.000 Kbps
  Last port reset:    1 hour, 20 minutes, 42 seconds ago

  Input frame errors:
  CRC error           0 alignment (byte length)           0
  missed frame        182 too long (> 2062 bytes)       0
  aborted frame       0 DMA/FIFO overrun              0
  Output frame counters:
  DMA/FIFO underrun errors 0 Output aborts sent              0
  
```

**Nt** Indicates the interface number as assigned by software during initial configuration.

**Nt'** Indicates the interface number as assigned by software during initial configuration.

## Monitoring Frame Relay Interfaces

**Note:** For FR dial circuit interfaces, Nt' is different from Nt. Nt' indicates the base interface (ISDN) that the dial circuit is running over.

### **Interface**

Indicates the type of interface and its instance number. Frame relay has a FR designation.

**Slot** Indicates the slot of the interface running Frame Relay

**Port** Indicates the port of the interface that is running Frame Relay

### **Self-test Passed**

Indicates the total number of times the Frame Relay interface passed self-test.

### **Self-test Failed**

Indicates the total number of times the Frame Relay interface failed self-test.

### **Maintenance Failed**

Indicates the total number of times the interface was unable to communicate with Frame Relay management.

### **V.24 circuit, Nicknames, and State**

The circuits, control signals, pin assignments and their state (ON or OFF).

**Note:** The symbol - - - in monitoring output indicates that the value or state is unknown.

### **Line speed**

The transmit clock rate.

### **Last port reset**

The length of time since the last port reset.

### ***Input frame errors:***

#### **CRC error**

The number of packets received that contained checksum errors, and as a result were discarded.

#### **Alignment**

The number of packets received that were not an even multiple of 8 bits in length, and as a result were discarded.

#### **Too long**

The number of packets that were greater than the configured size, and as a result were discarded.

#### **Aborted frame**

The number of packets received that were aborted by the sender or a line error.

#### **DMA/FIFO overrun**

The number of times the serial interface could not send data fast enough to the system packet buffer memory to receive them from the network.

#### **Missed frame**

When a frame arrives at the device and there is no buffer available, the hardware drops the frame and increments the missed frame counter.

#### **L & F bits not set**

On serial interfaces, the hardware sets input-descriptor information for arriving frames. If the buffer can accept the complete frame upon arrival, the hardware sets both the last and first bits of the frame, indicating that the



## Monitoring Frame Relay Interfaces

buffer accepted the complete frame. If either of the bits is not set, the packet is dropped, the L & F bits not set counter is incremented, and the buffer is cleared for reuse. This counter will not be displayed for all types of adapter.

**Note:** It is unlikely that the L & F bits not set counter will be affected by traffic.

### **Output frame counters:**

#### **DMA/FIFO underrun errors**

The number of times the serial interface could not retrieve data fast enough from the system packet buffer memory to transmit them to the network.

#### **Output aborts sent**

The number of transmissions that were aborted as requested by upper-level software.

Statistics similar to the following are displayed for Frame Relay dial circuits when you execute the **interface** command from the GWCON environment:

+interface 3

Nt	Nt'	Interface	Passed	Self-Test Failed	Self-Test Failed	Maintenance
3	2	FR/1		1	0	0

Frame Relay MAC/data-link on ISDN Primary Rate interface

---

## Frame Relay Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

Frame Relay supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

### GWCON (Talk 5) Activate Interface

Frame Relay supports the GWCON (Talk 5) **activate interface** command with the following considerations:

- You cannot activate a Frame Relay dial circuit interface unless the dial circuit's base net is already active.
- You cannot activate a Frame Relay dial circuit if its base net is set for channelized ISDN.
- An **activate** for a Frame Relay dial circuit will fail if the frame size, MAC header, or trailer required by the spare interface is larger than the values of these parameters configured for other dial circuits already assigned to the base net.

All Frame Relay configuration changes are automatically activated except the following changes:

Commands whose changes are not activated by the GWCON (Talk 5) activate interface command
---

CONFIG, net, enable compression
---------------------------------

<b>Note:</b> If data compression is not already active on another Frame Relay interface, then it cannot be enabled when the interface is activated.
---

## Monitoring Frame Relay Interfaces

### GWCON (Talk 5) Reset Interface

Frame Relay supports the GWCON (Talk 5) **reset interface** command with the following considerations:

- A Frame Relay dial circuit cannot be reset if any of the dial circuit parameters that are configured at the Dial Circuit config> prompt have changed.
- You cannot reset a Frame Relay interface that is being used for WAN Reroute

All Frame Relay configuration changes are automatically activated except the following changes:

Commands whose changes are not activated by the GWCON (Talk 5) reset interface command
--

CONFIG, net, set frame-size
-----------------------------

<b>Note:</b> You cannot increase the frame size.
--

CONFIG, net, enable compression
---------------------------------

<b>Note:</b> You cannot enable compression on the interface if it is not enabled already or enabled on another Frame Relay Interface.
---

### GWCON (Talk 5) Temporary Change Commands

Frame Relay supports the following GWCON commands that temporarily change the operational state of the device. These changes are lost whenever the device is reloaded, restarted, or you execute any dynamically reconfigurable command.

Commands
----------

GWCON, net, set circuit
-------------------------

GWCON, net, set ir-adjustment
-------------------------------

GWCON, net, enable cir-monitor
--------------------------------

GWCON, net, enable cllm
-------------------------

GWCON, net, enable congestion-monitor
---------------------------------------

GWCON, net, enable notify-fecn-source
---------------------------------------

GWCON, net, enable throttle-transmit-on-fecn
--

GWCON, net, disable cir-monitor
---------------------------------

GWCON, net, disable cllm
--------------------------

GWCON, net, disable congestion-monitor
--

GWCON, net, disable notify-fecn-source
--

GWCON, net, disable throttle-transmit-on-fecn
---

---

## Chapter 43. Using Point-to-Point Protocol Interfaces

This chapter describes how to use the Point-to-Point Protocol for interfaces on the device. Sections in this chapter include:

- “PPP Overview”
- “The PPP Link Control Protocol (LCP)” on page 583
- “PPP Authentication Protocols” on page 587
- “Using AAA with PPP” on page 591
- “The PPP Network Control Protocols” on page 591
- “Using and Configuring Virtual Connections” on page 594

See “Chapter 45. Using the Multilink PPP Protocol” on page 645 and “Chapter 46. Configuring and Monitoring Multilink PPP Protocol (MP)” on page 651 for information about using the Multilink PPP Protocol.

---

### PPP Overview

PPP provides a method for transmitting protocol datagrams at the Data Link Layer over serial point-to-point links. PPP provides the following services:

- Link Control Protocol (LCP) to establish, configure, and test the link connection.
- Encapsulation protocol for encapsulating protocol datagrams over serial point-to-point links.
- Authentication protocols (APs) to validate the identity of a peer (remote) unit, and to submit your own identity to the peer for validation.
- Network Control Protocols (NCPs) for establishing and configuring different network layer protocols. PPP allows the use of multiple network layer protocols.

Figure 45 shows some examples of point-to-point serial links.

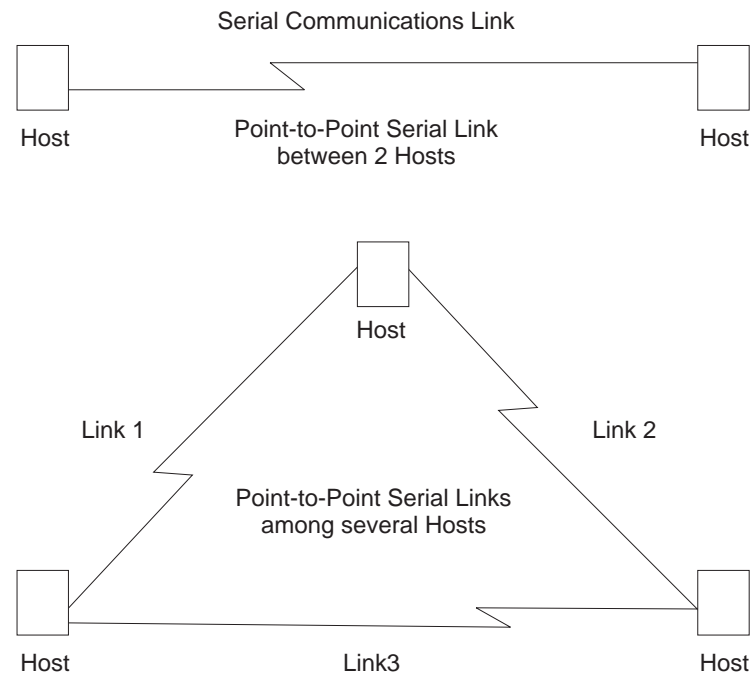


Figure 45. Examples of Point-to-Point Links

PPP currently supports the following control protocols:

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- AppleTalk Control Protocol (ATCP)
- DECnet Protocol Control Protocol (DNCP)
- Banyan VINES Control Protocol (BVCP)
- Bridging protocols (BCP, NBCP, and NBFCP)
- Internet Protocol Control Protocol (IPCP)
- Internet Protocol Version 6 Control Protocol (IPv6CP)
- IPX Control Protocol (IPXCP)
- APPN HPR Control Protocol (APPN HPRCP)
- APPN ISR Control Protocol (APPN ISRCP)
- OSI Control Protocol (OSICP)

Each end starts by sending LCP packets to configure and test the data link. After the link has been established, PPP sends NCP packets to choose and configure one or more network layer protocols. After network layer protocols have been configured, datagrams from each network layer can be sent over the link. The next sections explain these concepts in more detail.

## PPP Data Link Layer Frame Structure

PPP transmits data frames that have the same structure as High-level Data Link Control (HDLC) frames. PPP uses a byte-oriented transmission method with a single-frame format for all data and control exchanges. Figure 46 illustrates the PPP frame structure and is followed by a detailed description of each field.

Flag	Address	Control	Protocol	Information	FCS	Flag
8 bits	8 bits	8 bits	16 bits	variable	16 bits	8 bits

Figure 46. PPP Frame Structure

### Flag Fields

The flag field begins and ends each frame with a unique pattern of 01111110. Generally a single flag ends one frame and begins the next. The receiver attached to the link continuously search for the flag sequence to synchronize the start of the next frame.

### Address Field

The address field is a single octet (8 bits) and contains the binary sequence 11111111 (0xff hexadecimal). This is known as the All-Station Address. PPP does not assign individual station addresses.

### Control Field

The control field is a single octet and contains the binary sequence 00000011 (0x03 hexadecimal). This sequence identifies the Unnumbered Information (UI) command with the P/F bit set to zero.

### Protocol Field

The protocol field is defined by PPP. The field is 2 octets (16 bits) and its value identifies the protocol datagram encapsulated in the Information field of the frame.

Protocol field values in the range '0xC000'–'0xFFFF' indicate Layer 3 data (protocol datagrams) such as LCP, PAP, CHAP,

### Information Field

The information field contains the datagram for the protocol specified in the protocol field. This is zero or more octets.

When the protocol type is LCP, exactly one LCP packet is encapsulated in the information field of PPP Data Link Layer frames.

### Frame Check Sequence (FCS) Field

The frame check sequence field is a 16-bit cyclic redundancy check (CRC).

PPP links can negotiate the use of various options which may modify the basic frame format; the description below applies to the frame format prior to any such modifications. PPP LCP packets are always sent in this format as well, regardless of negotiated options, so that LCP packets can be recognized even when there is a loss of synchronization on the line.

The router supports two such options: Address and Control Field Compression (ACFC) and Protocol Field Compression (PFC). These are described in detail in a later section.

---

## The PPP Link Control Protocol (LCP)

PPP's Link Control Protocol (LCP) establishes, configures, maintains, and terminates the point-to-point link. This process is carried out in four phases:

1. Before exchanging any network layer datagrams, PPP first opens the connection through an exchange of LCP configuration packets. As part of this negotiation process, the PPP processes at each end of the link agree on various basic link level parameters such as the maximum packet size that can be transferred and whether the ends must use an authentication mechanism to identify themselves to their peers before carrying network traffic.  
If this negotiation is unsuccessful, the link is considered to be "down" and incapable of carrying any network traffic. If the negotiation is successful, LCP goes to an "Open" state and PPP goes on to the next phase.
2. After LCP successfully reaches an Open state, the next step in establishing the link is to perform authentication where each end of the link identifies itself to the other end using the "authentication protocol" that the other end dictated as part of the LCP negotiation.  
If authentication fails, the link is marked "down" and cannot carry any network traffic. If authentication succeeds or if authentication is not required, the PPP link moves to the next phase.
3. After authentication is negotiated, the peers negotiate encryption for the link. After authentication phase is complete, the router negotiates the use of encryption using Encryption Control Protocol (ECP) packets where each end of the link negotiates which encryption algorithm will be used to encrypt the data over this PPP link. If ECP did not reach "Open" state then the link is marked "down" and cannot carry any network traffic. If ECP successfully reaches "Open" state, or if encryption is not required, the PPP link moves to the next phase, NCP negotiation (except ECP, which is technically also an NCP). The link is considered to be "open" or "up" at this time, though it cannot yet carry layer-3 protocol datagrams.
4. Once the link is open, the router negotiates the use of various layer-3 protocols (for example, IP, IPX, DECnet, Banyan Vines) using Network Control Protocol (NCP) packets. Each layer-3 protocol has its own associated network control protocol. For example IP has IPCP and IPX has IPXCP. The basic format and mechanisms for all these NCP packets is the same for all protocols, and is basically a superset of the LCP mechanisms as described later in this section. Each layer-3 protocol is negotiated independently. When a particular NCP successfully negotiates, the link is "up" for that protocol's traffic. As with LCP,

## Using PPP

configuration information can be exchanged as part of this negotiation; for example, IPCP can exchange IP addresses or negotiate the use of "Van Jacobson IP header compression".

As with LCP, it is possible for an NCP to fail to negotiate successfully with its peer. This might happen because the peer does not support a particular protocol or because some configuration option was unacceptable. If an NCP fails to reach the "Open" state, no layer-3 protocol packets can be exchanged for that protocol even though other layer-3 protocols are successfully passing traffic across the PPP link.

5. Finally, LCP has the ability to terminate the link at any time. This is usually done at the request of the user but may occur for other reasons such as: an administrative closing of the link, idle timer expiration, or failure to re-authenticate on a CHAP rechallenge.

For complete details about PPP LCP, authentication, and the general NCP negotiation mechanisms, consult RFCs 1331, 1334, 1570, and 1661.

## LCP Packets

LCP packets are used to establish and manage a PPP link and can be loosely divided into three categories:

- *Link establishment packets* that exchange configuration information and establish the link.
- *Link termination packets* that shut down the link or signal that a link is not accepting connections at a particular time. They also can be used to signal that a particular protocol is unrecognized (for example, during NCP negotiations).
- *Link maintenance packets* that monitor and debug a link.

Exactly one LCP packet is encapsulated in the information field of PPP Data Link Layer frames. In the case of LCP packets, the protocol field reads "Link Control Protocol" (C021 hexadecimal). Figure 47 illustrates the structure of the LCP packet and is followed by a detailed description of each field.

Code	Identifier	Length	Data(option)
------	------------	--------	--------------

Figure 47. LCP Frame Structure (in PPP Information Field)

**Code** The code field is one octet in length and identifies the type of LCP packet. The codes in Table 77 on page 585 distinguish the packet types. They are described in more detail in later sections.

Table 77. LCP Packet Codes

Code	Packet Type
1	Configure-Request (Link Establishment)
2	Configure-Ack (Link Establishment)
3	Configure-Nak (Link Establishment)
4	Configure-Reject (Link Establishment)
5	Terminate-Request (Link Termination)
6	Terminate-Ack (Link Termination)
7	Code-Reject (Link Establishment)
8	Protocol-Reject (Link Establishment)
9	Echo-Request (Link Maintenance)
10	Echo-Reply (Link Maintenance)
11	Discard-Request (Link Maintenance)

**Identifier**

The identifier field is one octet in length and is used to match packet requests to replies.

**Length**

The length field is two octets in length and indicates the total length (that is, including all fields) of the LCP packet.

**Data (Option)**

The data field is zero or more octets as indicated by the length field. The format of this field is determined by the code.

NCP packets are structured identically to LCP packets and are distinguished by having different PPP “Protocol” values. Each LCP packet type (distinguished by the code field) has the same meaning for each NCP, though an individual NCP may not implement all possible LCP packet types. NCPs normally implement all of the link establishment type packets that LCP defines. They may implement some of the additional LCP packet types, and they also may define additional packet types beyond what LCP uses. Unlike LCP packets, the structure of an NCP frame may be modified according to options negotiated by LCP during the link establishment phase.

## Link Establishment Packets

Link Establishment Packets establish and configure a point-to-point link including the following packet types:

**Configure-Request**

LCP packet code field is set to 1. LCP transmits this packet type when it wants to open a point-to-point link. Upon receiving a Configure-Request, a peer station’s LCP entity sends an appropriate reply, depending on whether it is ready to process packets.

**Configure-Ack**

LCP packet code field is set to 2. The peer transmits this packet type when every configuration option in a Configure-Request packet is acceptable. Upon receiving the Configure-Ack (ack = acknowledgment), the originating station checks the Identifier field. This field must match the one from the last-transmitted Configure-Request or the packet is invalid.

Both ends send Configure-Request and both ends must receive a Configure-Ack before the link opens. Options negotiated for one direction may differ from that negotiated for the other direction. There is no “master-slave” relationship. Rather, each end works symmetrically.



## Using PPP

### Configure-Nak

LCP packet code field is set to 3. The peer transmits this packet type when some part of the configuration option in a Configure-Request packet is unacceptable. The Identifier field is copied from the received Configure-Request and the Data (option) field is filled with the received unacceptable configuration options. The Identifier field must match the one from the last-transmitted Configure-Request or the packet is invalid and is discarded.

When the originator receives a Configure-Nak packet, a new Configure-Request packet is sent that includes modified, acceptable configuration options.

### Configure-Reject

LCP packet code field is set to 4. The peer transmits this packet type when some part of the configuration options in a Configure-Request packet is unacceptable. The Identifier field is copied from the received Configure-Request and the Data (option) field is filled with the received unacceptable configuration options. The Identifier field must match the one from the last-transmitted Configure-Request or the packet is invalid and is discarded.

When the originator receives a Configure-Reject packet, a new Configure-Request packet is sent that does not include any of the configuration options received in the Configure-Reject packet.

### Code-Reject

LCP packet code field is set to 7. The transmission of this packet type indicates that the LCP “code” field on a received packet is not recognized as a valid value. While this can indicate an error, it also can indicate that the peer does not implement some feature that you are trying to use.

### Protocol-Reject

LCP packet code field is set to 8. The transmission of this packet type indicates that a PPP frame has been received that contains an unsupported or unknown protocol (the PPP “protocol” field was unrecognized for some packet). This usually occurs if you try to negotiate some NCP for a protocol that the other end doesn’t support. For example, if DECnet CP (DNCP) sends a Config-Request and the other end does not know about DECnet, the other end replies with an LCP Protocol-Reject on DNCP. Upon receiving a Protocol-Reject packet, the link stops transmitting the incorrect protocol.

**Note:** NCP packet types and structure are the same as LCP, although there are a few additional “code” fields associated with some NCPs.

## Link Termination Packets

Link Termination Packets terminate a link and include the following packet types:

### Terminate-Request

LCP packet code field is set to 5. LCP transmits this packet type when a point-to-point link needs to be closed. These packets are sent until a Terminate-Ack packet is sent back, or until a retry counter is exceeded while waiting for an Ack.

### Terminate-Ack

LCP packet code field is set to 6. Upon receiving a Terminate-Request packet, this packet type must be transmitted with the code field set to 6. Reception of a Terminate-Ack packet that was not expected indicates that the link has been closed.



## Link Maintenance Packets

Link Maintenance Packets manage and debug a link, and include the following packet types:

### Echo-Request and Echo-Reply

LCP packet code fields are set to 9 and 10 respectively. LCP transmits these packet types in order to provide a Data Link Layer loopback mechanism for both directions on the link. This feature is useful, for example, in debugging a faulty link to determine link quality. These packets are sent only when the link is in the Open state.

### Discard-Request

LCP packet code field is set to 11. LCP transmits this packet type to provide a data sink for Data link Layer testing. A peer that receives a Discard-Request *must* throw away the packet. This is useful in debugging a link. These packets are sent only when the link is in the Open state.

---

## PPP Authentication Protocols

PPP authentication protocols provide a form of security between two nodes connected via a PPP link. If authentication is required on a box, then immediately after the two boxes successfully negotiate the use of the link at the LCP layer (LCP packets are exchanged until LCP goes into an “open” state), they go into an “authentication” phase where they exchange authentication packets. A box is neither able to carry network data packets nor negotiate the use of a network protocol (NCP traffic) until authentication negotiation completes successfully.

There are different authentication protocols in use: Password Authentication Protocol (PAP) and Challenge/Handshake Authentication Protocol (CHAP). Microsoft PPP CHAP (MS-CHAP) is also available to authenticate Windows workstations and peer routers. PAP and CHAP are described in detail in RFC 1334, and briefly described later in this section. MS-CHAP is described in RFC 1994.

On remote dial-in access ports, a third authentication protocol is available. This is Shiva Password Authentication Protocol (SPAP), which is a Shiva proprietary protocol. See “Shiva Password Authentication Protocol (SPAP)” on page 588 for more information.

Whether a box requires the other end to authenticate itself (and if so, with what protocol) is determined during the LCP negotiation phase. Authentication could be considered to “fail” even at the link establishment phase (LCP negotiation), if one end does not know how, or refuses to use, the authentication protocol the other end requires.

Each end of a link sets its own requirements for how it wants the other end to authenticate itself. For example, given two routers “A” and “B”, connected over a PPP link, side A may require that B authenticate itself to A using PAP, and side B may require that A similarly identify itself using CHAP. It is valid for one end to require authentication while the other end requires none.

In addition to initial authentication during link establishment, with some protocols an authenticator may demand that the peer reestablish its credentials periodically. With CHAP, for example, a rechallenge may be issued at any time by the authenticator and the peer must successfully reply - or lose the link.

## Using PPP

If more than one authentication protocol is enabled on a link, the router initially attempts to use them in the following priority order:

1. MS-CHAP
2. CHAP
3. PAP
4. SPAP

**Note:** SPAP is only available on interfaces that have IBM DIALs Dial-In circuits configured.

If the remote side responds to the authentication request with NAK and suggests an alternative, the router uses the alternative, provided that it is enabled on the link. If the remote side continues responding to the router's suggestions with NAK but does not provide an alternative that the router has enabled, the link is terminated.

## Password Authentication Protocol (PAP)

The Password Authentication Protocol (PAP) provides a simple method for the peer to establish its identity using a two-way handshake. This is done only upon initial link establishment. Following link establishment, the peer sends an ID/Password pair to the authenticator until authentication is acknowledged or the connection is terminated. Passwords are sent over the circuit "in the clear," and there is no protection from playback or repeated trial and error attacks. The peer controls the frequency and timing of the attempts.

## Challenge-Handshake Authentication Protocol (CHAP)

The Challenge-Handshake Authentication Protocol (CHAP) is used to periodically verify the identity of the peer using a three-way handshake. This is done upon initial link establishment, and *may* be repeated anytime after the link has been established. After the initial link establishment, the authenticator sends a "challenge" message to the peer. The peer responds with a value calculated using a "one-way hash" function. The authenticator checks the response against its own calculation of the expected hash value. If the values match, the authentication is acknowledged; otherwise the connection is terminated.

## Microsoft PPP CHAP Authentication (MS-CHAP)

MS-CHAP is an extension to PPP CHAP that is used to authenticate remote Windows workstations and peer routers. Both MS-CHAP and CHAP use PPP's Link Control Protocol (LCP) to negotiate the desired authentication protocol in one or both directions; both use the CHAP protocol identifier as the PPP protocol; and each protocol uses a random challenge which is encrypted as part of the response.

MS-CHAP can be used with the internal PPP user Local List database, but **not** with the external AAA authentication server that is described in the chapter "Using Local or Remote Authentication" in *Using and Configuring Features*. If you plan to use Microsoft PPP Encryption (MPPE) on a PPP interface, you must enable MS-CHAP on that interface before you configure MPPE. Use the talk 6 command **enable mschap** to enable MS-CHAP.

## Shiva Password Authentication Protocol (SPAP)

**Note:** SPAP is only available on interfaces that have IBM DIALs Dial-In circuits configured.

The Shiva Password Authentication Protocol (SPAP) provides a simple method for the peer to establish its identity using a 2-way handshake similar to PAP. After the

Link Establishment phase is complete, an Id/Password is repeatedly sent by the peer to the authenticator until authentication is acknowledged, the connection is terminated, or a retry counter expires.

SPAP is a moderately strong authentication protocol that uses a proprietary encryption algorithm for the password. In addition to authentication, SPAP offers:

- The ability to change a password.
- The ability for the router to send a configurable banner requiring acknowledgment from the client after password authentication.
- The ability to use callback as an additional security feature.
- Virtual connections.

## Configuring PPP Authentication

The following sections describe configuring PPP authentications for two situations:

- Configuring the 2216 to authenticate a remote device.
- Configuring the 2216 to be authenticated by a remote device.

These two situations are independent. You can do one or the other.

### Configuring a PPP Interface to Authenticate a Remote Device

To authenticate a remote device or dial-in client:

1. Enable authentication on the PPP interface
  - At the `Config>` prompt, enter the **network** command to select the PPP interface to configure.
  - At the PPP `Config>` prompt, enable the authentication protocol you want to use.

You can use any of the following protocols:

- PAP
- MS-CHAP

**Note:** MS-CHAP can use the PPP local database to authenticate, but cannot use an authentication server.

- CHAP
- SPAP

**Note:** SPAP is only available on interfaces that have IBM DIALs Dial-In circuits configured.

2. Decide whether to authenticate locally or through an authentication server.
  - To authenticate locally, enter the name and password into the PPP user database.
 

At the `Config>` prompt, use the **add ppp\_user** command. See “Add” on page 72 for more information.

A 2216 maintains a single PPP user database. When the remote router or device sends its name and password to the device during the authentication phase, the device checks to see if that name and password are in the PPP user database.
  - To authenticate through an authentication server using TACACS, TACACS+, or RADIUS, you must configure the device to reach the authentication server and the name and password must be in the server’s database. Refer to “Using Local or Remote Authentication” in *Using and Configuring Features*.

### Configuring a PPP Interface to be Authenticated by a Remote Device

To configure the device to be authenticated by a remote device or dial-in client, configure the device's name and password:

1. At the `Config>` prompt, select the interface you are configuring using the **network** command.
2. At the `PPP Config>` prompt, type the **set name** command and provide the name and password that the device will use to identify itself to the remote router or device during the authentication phase.

**Attention:** Do not use the following commands unless you want the device to perform authentication as described in "Using Local or Remote Authentication" in *Using and Configuring Features* .

- **enable pap**
- **enable chap**
- **enable spap**

**Note:** SPAP is only available on interfaces that have IBM DIALs Dial-In circuits configured.

- **enable mschap**

### Configuring PPP Callback

Callback is a PPP feature associated with single user dial-in solutions. It attempts to accomplish two objectives. These objectives are:

- Callback can be used as a form of security. When used in this way, callback is generally referred to as required callback. When required callback is negotiated the user will be dialed back at a predetermined number. Only then will the PPP link be allowed to come up.
- Callback can also be implemented as a toll-saver feature. When used in this way, callback is generally referred to as roaming callback. Unlike required callback, roaming callback is requested by the client. The primary function of roaming callback is to bill the company maintaining the DIALs Server the toll charges instead of the user.

Callback is supported only on dial-in dial circuits over ISDN networks.

#### Example 1: Required callback enabled

```
Config>add PPP
Enter user name: [ ]? nocalldback
Password:
Enter password again:
Is this a Single-User or a Network? (Single-User, Network): [Single-User]

IP address for user nocalldback [0.0.0.0]?
Enter HostName: [ ]?
Give 'nocalldback' default time allotted ? (Yes, No): [Yes]
Enable Callback for 'nocalldback' ? (Yes, No): [No] yes
Type of Callback (Roaming Callback, Required Callback): [Roaming Callback] Requ
Dialback number for this user [ ]? 555-1234
Will 'nocalldback' be able to dial-out ? (Yes, No): [No]

PPP User Name: nocalldback
Type: Single User
User IP Address: Interface Default
SubNetMask: 255.255.255.255
Hostname: <undefined>
Time-Allotted: Box Default
Call-Back Type: Required Callback
Phone Number: 543-3186
Dial-Out: Not Enabled
Encryption: Not Enabled

Is information correct? (Yes, No, Quit): [No] yes
```

#### Example 2: Callback disabled

```

Config>add PPP
Enter user name: [ ]? sallydoe
Password:
Enter password again:
Is this a Single-User or a Network? (Single-User, Network): [Single-User]

IP address for user nocalcallback [0.0.0.0]?
Enter HostName: [ ]?
Give 'no callback' default time allotted ? (Yes, No): [Yes]
Enable Callback for 'no callback' ? (Yes, No): [No]
Will 'no callback' be able to dial-out ? (Yes, No): [No]

PPP User Name: no callback
Type: Single User
User IP Address: Interface Default
SubNetMask: 255.255.255.255
Hostname: <undefined>
Time-Allotted: Box Default
Call-Back Type: Not Enabled
Dial-Out: Not Enabled
Encryption: Not Enabled

Is information correct? (Yes, No, Quit): [No] yes

```

### Example 3: Roaming callback enabled

```

Config>add PPP roaming_callback
Password:
Enter password again:
Is this a Single-User or a Network? (Single-User, Network): [Single-User]

IP address for user roaming_callback [0.0.0.0]?
Enter HostName: [ ]?
Give 'roaming_callback' default time allotted ? (Yes, No): [Yes]
Enable Callback for 'roaming_callback' ? (Yes, No): [No] yes
Type of Callback (Roaming Callback, Required Callback): [Roaming Callback]

Will 'roaming_callback' be able to dial-out ? (Yes, No): [No]n

PPP User Name: roaming_callback
Type: Single User
User IP Address: Interface Default
SubNetMask: 255.255.255.255
Hostname: <undefined>
Time-Allotted: Box Default
Call-Back Type: Roaming Callback
Dial-Out: Not Enabled
Encryption: Not Enabled

Is information correct? (Yes, No, Quit): [No]yes

```

---

## Using AAA with PPP

See “Using Local or Remote Authentication” and “Configuring Authentication” in *Using and Configuring Features* for this information.

---

## The PPP Network Control Protocols

PPP has a family of Network Control Protocols (NCPs) for establishing and configuring different network layer protocols. The NCPs are responsible for configuring, enabling, and disabling the network layer protocols on both ends of the point-to-point link. NCP packets cannot be exchanged until LCP has opened the connection and the link reaches the OPEN state.

PPP supports the following Network Control Protocols:

- AppleTalk Control Protocol (ATCP)
- Banyan VINES Control Protocol (BVCP)
- Bridging protocols (BCP, NBCP, and NBFCP),
- Callback Control Protocol
- DECnet Control Protocol (DNCP)
- IP Control Protocol (IPCP)
- IPv6 Control Protocol (IPv6CP)
- IPX Control Protocol (IPXCP)

## Using PPP

- OSI Control Protocol (OSICP)
- APPN High Performance Routing Control Protocol (APPN HPRCP)
- APPN Intermediate Session Routing Control Protocol (APPN ISRCP)

## AppleTalk Control Protocol

ATCP is specified in Request for Comments (RFC) 1378. IBM's implementation of ATCP supports the AppleTalk-Address option. The implementation supports both full router mode and half router mode. For additional information, refer to "AppleTalk over PPP" in *Protocol Configuration and Monitoring Reference Volume 2*.

## Banyan VINES Control Protocol

RFC 1763 describes BVCP. IBM's implementation of BVCP does not support any options.

## Bridging Control Protocol

BCP is specified in RFC 1638. IBM's implementation of BCP supports the IEEE 802.5 Line Identification Option and the Tinygram Compression Option.

NetBIOS Control Protocol (NBCP) is a proprietary NCP developed by Shiva Corporation and used by the IBM Dial In Access to LAN Client for OS/2, DOS and Windows for single-user dial-in. NBCP is used to transport NetBIOS and LLC/802.2 bridged traffic from these clients, dialed into a 2216 DIALs Server, onto an attached LAN. IBM's implementation of NBCP supports the MAC-Address and NetBIOS Name Projection options.

NetBIOS Frame Control Protocol (NBFCP) is specified in RFC 2097. NBFCP is used by Microsoft Windows<sup>®</sup> 95 and Windows NT<sup>®</sup> Dial-Up Networking clients for single-user dial-in. NBFCP is used to transport NetBIOS bridged traffic from these clients, dialed into a 2216 DIALs Server, onto an attached LAN. IBM's implementation of NBFCP supports the Name-Projection, Peer-Information and IEEE-MAC-Address-Required options.

## Callback Control Protocol

**Note:** CBCP is only available on interfaces that have IBM DIALs Dial-in circuits configured.

Callback Control Protocol (CBCP) is used by Microsoft Dial-Up Networking clients to negotiate callback. The 2216 supports callback to a single user-specified number (roaming callback) and callback to an administrator-specified number (required callback). The CBCP option of calling a list of numbers is not supported.

PPP users that want to use CBCP callback must have some form of authentication enabled (like PAP, CHAP, SPAP or MS-CHAP). There are no configuration parameters for CBCP. (The client determines when it is used.) See "Configuring PPP Callback" on page 590 for information about configuring PPP users for callback.

## DECnet IV Control Protocol

DNCP is specified in RFC 1762. IBM's implementation does not support any DNCP options.

## IP Control Protocol

IPCP is specified in RFC 1332. IBM's implementation supports the following options:

- Van Jacobsen IP Header Compression as described in RFC 1144.
- Request an IP address

An IP address can be requested for this interface. If Dynamic-Address is enabled in the IP configuration for this interface, the peer will supply the address each time the connection is established.

- IP Address

The router can send its IP address, as well as accept an IP address, from a peer, or supply an IP address to a peer, if requested. If the router is configured to "Send Our Address" on a particular interface, and that interface has a valid, numbered IP address, then IPCP sends the address in its initial Configure-Request as option 3 (IP Address). IPCP also sends its address if the peer sends a Configure NAK with 0.0.0.0 for option 3 (IP Address), if a valid numbered address is configured for that PPP interface. IPCP will not send an unnumbered address to its peer.

A peer may specify its address (referred to as "Client Specified"), or request an address from the router by sending 0.0.0.0 for Option 3 in its initial Configure Request. The router may obtain this address from the authenticated user profile or from the interface itself. The user profile address takes precedence over the interface address. If you do not want to offer an address from the user profile, simply leave the address for that user in the profile as 0.0.0.0, and the router will offer the remote address configured for that interface. If there is no remote address configured for the interface or user profile, and the peer continues to request an address, IPCP will fail.

The router automatically adds a static route directed to the PPP interface for the address that is successfully negotiated, allowing data to be routed properly to the dial-in client. When the IPCP connection is ended for any reason, this static route is subsequently removed. By default, the net mask for this route is 255.255.255.255 (hostroute); however, if a net mask is specified in the authenticated user's profile (see "Configuring PPP Authentication" on page 589) a net mask other than this may be used to allow routing to more than a single host across the PPP link (RIP or other routing protocols could also be used to discover routes if desired).

- IP Header Compression as described in RFC 2507, RFC 2508 and RFC 2509.

## IPv6 Control Protocol

IPv6 Control Protocol is specified in RFC 2023. In IBM's implementation of IPv6CP, the router can send its IP address, as well as accept an IP address, from a peer, or supply an IP address to a peer, if requested. If the router is configured to "Send Our Address" on a particular interface, and that interface has a valid, numbered IP address, then IPv6CP sends the address in its initial Configure-Request as option 3 (IP Address). IPv6CP also sends its address if the peer sends a Configure NAK with ::/0 for option 3 (IP Address), if a valid numbered address is configured for that PPP interface. IPv6CP will not send an unnumbered address to its peer.

A peer may specify its address (referred to as "Client Specified"), or request an address from the router by sending ::/0 for Option 3 in its initial Configure Request. The router obtains this address from the interface. If there is no remote address configured for the interface, and the peer continues to request an address, IPv6CP will fail.



## Using PPP

The router automatically adds a static route directed to the PPP interface for the address that is successfully negotiated, allowing data to be routed properly to the dial-in client. When the IPv6CP connection is ended for any reason, this static route is subsequently removed. By default, the prefix length for this route is 128 (hostroute).

## IPX Control Protocol

IPXCP is specified in RFC 1552. IBM's implementation does not support any IPXCP options.

## OSI Control Protocol

OSICP is specified in RFC 1377. IBM's implementation of OSICP does not support any options.

## APPN HPR Control Protocol

Advanced Peer-to-Peer Networking<sup>®</sup> (APPN) High Performance Routing (HPR) control protocol is specified in RFC 2043. No options are negotiated for this control protocol.

## APPN ISR Control Protocol

Advanced Peer-to-Peer Networking (APPN) Intermediate Session Routing (ISR) control protocol is specified in RFC 2043. No options are negotiated for this control protocol.

See "Using and Configuring Data Encryption" in *Using and Configuring Features* for information about configuring encryption for a PPP interface.

---

## Using and Configuring Virtual Connections

Virtual Connections (VC) are DIALs dial-in circuits that can be suspended when they become inactive for a predetermined period of time. The ability to suspend the connections can help control your networking costs by saving line charges for DIALs dial-in clients that are not active; instead of keeping the connections active, the system saves information about the session and then closes the call. When the same DIALs dial-in client reconnects to the server, the session information is restored and the connection resumes as if there were no interruption. See "Configuring a VC" on page 595 for more information.

You can configure DIALs servers to end VCs that have been suspended for a specified amount of time. You can also manually end a VC at any time. See the **set** DIALs command and "DIALs Global Monitoring Commands" in *Using and Configuring Features* for related commands.

## VC Considerations

Keep the following in mind as you configure VCs:

- You can only use AAA local-list or RADIUS authentication when using VCs.
- A VC will not support IPX. When you configure a user to use VCs, IPX support for that user is disabled.
- The client configuration controls the suspension and resumption of a VC. The DIALs server cannot control that aspect of the connection.
- A VC can be established through an MP bundle.
- VCs cannot run over L2TP.



- Suspended VCs cannot be displayed with current network management tools.
- Do not assign an IP address to remote users by interface. Because another client could use an interface with which a client establishes a VC, when the VC attempts to reconnect with the server the connection will fail because the IP address is in use.
- A dial-in client must use SPAP for authentication.

## Configuring a VC

Configure VCs when you add a DIALs client at the Config> prompt. When you configure the user, you can either use the DIALs dial-in defaults (see the **set** DIALs command in the *Using and Configuring Features*) for the maximum suspend time and inactivity timeout, or configure specific values for the particular client. The following example shows the minimum configuration for a VC for DIALs dial-in client "jose."

```
Config>
Config> add ppp
Enter user name: []? jose
Password:
Enter password again:
Is this a 'DIALs' user? (Yes, No): [Yes]
Type of route? (hostroute, netroute): [hostroute]
IP address: [0.0.0.0]?
Enter hostname for dynamic DNS: []?
Allow Virtual Connections ? (Yes, No): [No] Yes
  Use Box Default inactivity timeout value and maximum suspended time? (Yes, No): [Yes] No
  User-based Max Suspend Time (hours)
  0-48 0=unlimited: [12] ? 10
  User-based Inactivity Timeout (seconds)
  10-1024: [30] ? 60
Give 'jose' default time allotted ? (Yes, No): [Yes]
Enable callback for 'jose' ? (Yes, No): [No]
Will 'jose' be able to dial-out ? (Yes, No): [No]

      PPP user name: jose
      User IP address: Interface Default
      Netroute Mask: 255.255.255.255
      Hostname:
      Time allotted: Box Default
      Callback type: Not Enabled
      Dial-out: Not Enabled

Is information correct? (Yes, No, Quit): [Yes]

User 'jose' has been added
Config>
```

To display the box-level default values for maximum virtual connections, idle timeout period, and the global default maximum suspend time, use the DIALs config>**list vc-parameters** command in the DIALs feature. To display these parameters along with the maximum suspend time and inactivity timeout for all virtual connections, use the **list all** command in the DIALs feature. See "DIALs Global Monitoring Commands" in *Using and Configuring Features*.



---

## Chapter 44. Configuring and Monitoring Point-to-Point Protocol Interfaces

This chapter describes Point-to-Point Protocol interface configuration and operational commands in the device. Sections in this chapter include:

- “Accessing the Interface Configuration Process”
- “Point-to-Point Configuration Commands” on page 598
- “Accessing the Interface Monitoring Process” on page 617
- “Point-to-Point Monitoring Commands” on page 617
- “Point-to-Point Protocol Interfaces and the GWCON Interface Command” on page 641
- “Point-to-Point Protocol Dynamic Reconfiguration Support” on page 643

---

### Accessing the Interface Configuration Process

Use the following procedure to access the router’s configuration process. This process gives you access to a specific interface’s *configuration* process.

1. At the OPCON prompt (\*), enter the **status** command to find the PID for CONFIG. (See page 9 for sample output of the **status** command.)
2. At the OPCON prompt, enter the OPCON **talk** command and the PID for CONFIG. (For more detail on this command, refer to “What is the OPCON Process?” on page 31.) For example:

```
* talk 6
```

After you enter the talk 6 command, the CONFIG prompt (Config>) displays on the console. If the prompt does not appear when you first enter **CONFIG**, press **Return** again.

3. At the CONFIG prompt, enter the **list devices** command to display the network interface numbers for which the router is currently configured.
4. Record the interface numbers.
5. Enter the CONFIG **network** command and the number of the interface you want to configure. For example:

```
Config> network 1
```

The appropriate configuration prompt (such as TKR Config> for token-ring), now displays on the console.

**Note:** Not all network interfaces are user-configurable. For interfaces that cannot be configured, you receive the message:

```
That network is not configurable
```

### Accessing the PPP Interface Configuration Prompt

To display the PPP config> prompt:

1. Enter **list devices** at the Config> prompt to display a list of interfaces.
2. If you have not already done so, set the data link protocol on one of the serial interfaces to PPP by entering **set data-link ppp** at the Config> prompt. For example:

```
Config> set data-link ppp  
Interface Number [0]? 2
```

3. Enter **network** followed by the number of the PPP interface. For example:

```
Config> network 2  
PPP config>
```

## Point-to-Point Configuration Commands

Table 78 summarizes the PPP configuration commands, and the rest of this section explains these commands. Enter the commands at the PPP `config>` prompt.

Table 78. Point-to-Point Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Disable	Disables data compression (CCP), DTR line handling, CHAP, PAP, ECP. Also disables SPAP authentication in Remote LAN Access Features images.
Enable	Enables data compression (CCP), DTR line handling, CHAP, PAP, ECP. Also enables SPAP authentication in Remote LAN Access Features images.
List	Lists all information related to the point-to-point interfaces protocols, parameters, and options.
Set	Sets physical line (HDLC) parameters, LCP parameters, generic NCP parameters, and various NCP-specific options.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Disable

Disables data compression, authentication protocols, PPP maintenance packets, multilink PPP, and the Lower DTR feature.

#### Syntax:

```
disable                ccp
                        chap
                        enp
                        lower-dtr
                        mp
                        mppe
                        mschap
                        pap
                        ppp-echo
```

- ccp** Disables the use of data compression on the interface. Refer to “Configuring and Monitoring Data Compression” in the *Using and Configuring Features* for more information.
- chap** Disables the use of the Challenge-Handshake Authentication Protocol. Refer to “Challenge-Handshake Authentication Protocol (CHAP)” on page 588 for more information.
- ecp** This allows the router not to force the use of ECP encryption on this interface. The interface will still accept and execute Encryption Control Protocol (ECP) if the peer is using ECP.

## Configuring PPP Interfaces (Talk 6)

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See the CONFIG process **load** command in *Nways Multiprotocol Access Services Software User's Guide*.

The use of multiple encryption (using encryption at both the IP Security Layer and at the Frame Relay or PPP data-Link Layer) within the router is restricted by U.S.A. Government export regulations. It is only supported in software loads that are under strict export control (software loads that support RC4 with 128 bit keys and Triple DES).

### lower-dtr

Determines the way the data terminal ready (DTR) signal is handled for leased serial-line interfaces that are disabled. If this parameter is set to "disabled" (the default) and the interface is disabled, the DTR signal is not dropped.

**mp** Disables the Multilink Protocol (MP) on this interface. See "Chapter 45. Using the Multilink PPP Protocol" on page 645 for more information.

#### Example:

```
disable mp
Disabled as a MP link
```

**mppe** Disables Microsoft Point-to-Point Encryption (MPPE) on this interface.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See "Load" on page 95.

### mschap

Disables MS-CHAP authentication on this interface. Disabling MS-CHAP has two effects upon MPPE, depending upon whether MPPE is configured as mandatory or optional. If MPPE is mandatory, disabling MS-CHAP brings down the link. If MPPE is optional, disabling MS-CHAP disables MPPE over the link. See "Microsoft PPP CHAP Authentication (MS-CHAP)" on page 588 for more information.

**pap** Disables the use of the Password Authentication Protocol. Refer to "Password Authentication Protocol (PAP)" on page 588 for more information.

### ppp-echo

Disables the sending of PPP maintenance packets.

**spap** Disables the use of the Shiva Password Authentication Protocol (SPAP).

**Note:** SPAP is only available on interfaces that have IBM DIALs Dial-In circuits configured.

## Enable

Enables data compression, encryption, authentication protocols, lower-DTR, PPP maintenance packets, and the multilink PPP protocol on this PPP interface. If multiple authentication protocols are enabled, the device attempts to use them in the following priority order:

1. MS-CHAP
2. CHAP
3. PAP

#### Syntax:

## Configuring PPP Interfaces (Talk 6)

<u>enable</u>	<u>ccp</u>
	<u>chap</u>
	<u>ecp</u>
	<u>lower-dtr</u>
	<u>mp</u>
	<u>mppe</u>
	<u>mschap</u>
	<u>pap</u>
	<u>ppp-echo</u>

**ccp** Enables the use of data compression on the interface.

**Note:** It is not recommended that you enable data compression for a PPP interface on a HSSI adapter.

**chap** Enables the use of the Challenge-Handshake Authentication Protocol. You are prompted for a rechallenge interval. Specify 0 if you do not want to rechallenge periodically after the initial authentication phase is complete. Refer to “Challenge-Handshake Authentication Protocol (CHAP)” on page 588 for more information.

**Example:**

```
enable chap
Rechallenge Interval in seconds (0=NONE) [0] 10
CHAP enabled
```

**ecp** Enables the use of data encryption on this interface by negotiating Encryption Control Protocol (ECP). Once this is done, all PPP users with encryption enabled and with a valid encryption key must use ECP to connect to this port unless MS-CHAP is the active authentication protocol for the link. If the authentication protocol is MS-CHAP, ECP cannot be used; encryption must be accomplished using MPPE. PPP users without encryption enabled will still be able to connect to this interface.

When you enable ECP, you are prompted to enter the ECP encryption key for the local router. You must also provide the encryption key for the remote user when you use the talk 6 **add ppp-user** command at the Config> prompt to configure the remote user. MPPE does not require you to configure an encryption key on either the local or the remote user.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

**lower-dtr**

Determines the way the data terminal ready (DTR) signal is handled for leased serial-line interfaces that are disabled. If this parameter is set to “disabled” (the default) and the interface is disabled, the DTR signal is not dropped.

If Lower DTR is set to “enabled”, then the DTR signal will be dropped when the interface is disabled. This behavior may be desirable in situations where the interface has been configured as an alternate link for WAN Reroute and the interface is connected to a dial-out modem which maintains its dial connection based on the state of the DTR signal.

When the interface is disabled, the DTR signal is low and the modem keeps the dial connection down. When the interface is enabled, due to a

## Configuring PPP Interfaces (Talk 6)

WAN Reroute backup scenario, DTR is raised and the modem dials a stored number to the backup site. When the primary interface is restored, the alternate interface is disabled, DTR is lowered, and the modem hangs up the dial connection.

The following cable types are supported:

- RS-232
- V.35
- V.36

**Note:** The **enable lower-dtr** command is not supported on PPP dial circuit interfaces.

**mp** Enables the Multilink Protocol (MP) on this interface. See “Chapter 45. Using the Multilink PPP Protocol” on page 645 for more information.

**Example:**

```
enable mp
Enabled as a MP link
Is this link a dedicated MP link? [no] yes
MP interface for this MP link? [0] 3
```

**mppe** [*mandatory/optional*] [*stateless/stateful*]

Enables Microsoft Point-to-Point Encryption (MPPE). If MS-CHAP is not enabled on the interface, then MPPE cannot be enabled on that interface. See Microsoft Point-to-Point Encryption (MPPE) in the chapter “Using and Configuring Encryption Protocols” in *Using and Configuring Features* for more information.

**mandatory**

The client and the server must negotiate MPPE or the link will drop.

**optional**

The client will attempt to negotiate MPPE, but if the negotiation fails, the PPP link will remain active.

**stateless**

Session keys will be regenerated after transmitting each packet. This function is currently not supported by Microsoft Dial-Up Networking (DUN) clients.

**stateful**

Session keys will be regenerated after transmitting every 256 packets.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95 for more information.

**mschap**

Enables MS-CHAP authentication. When you enable MS-CHAP, you are prompted to provide the authenticator rechallenge interval. This value in seconds defines the length of time that will pass before the authenticator sends another challenge to the receiver of the authentication request to reconfirm the authentication. The value 0 indicates that no further challenges will be sent after the initial authentication.

Use the **set name** command to configure the name of the 2216 if the peer router is configured to authenticate the 2216’s local name.

Note that MS-CHAP cannot be enabled if an external authentication server, as described in the chapter “Using Local or Remote Authentication” in *Using*

## Configuring PPP Interfaces (Talk 6)

*and Configuring Features*, has been configured. See “Microsoft PPP CHAP Authentication (MS-CHAP)” on page 588 for more information.

**pap** Enables the use of the Password Authentication Protocol. Refer to “Password Authentication Protocol (PAP)” on page 588 for more information.

### **ppp-echo**

Enables the sending of PPP maintenance packets, which are used to validate the connection.

## List

Use the **list** command to display information related to the PPP interface and its protocol parameters and options.

### **Syntax:**

```
list                all  
                    bcp  
                    ccp  
                    ecp  
                    hdlc  
                    ipcp  
                    ipv6cp  
                    lcp  
                    ncp
```

**all** Lists all options and parameters related to the PPP interface.

The **list all** command displays the output of *all* the individual **list...** parameters described below.

**bcp** Lists the Bridging Network control protocol options.

#### **Example:**

```
list bcp  
BCP Options  
-----  
Tinygram Compression:DISABLED
```

#### **Tinygram Compression:**

Displays whether Tinygram Compression is enabled/disabled.

**ccp** Displays the currently selected data compression options if data compression has been enabled. For additional information, see “Configuring and Monitoring Data Compression” in *Using and Configuring Features*.

If Microsoft Point-to-Point Encryption (MPPE) and data compression are both enabled, the type of data compression is MPPC.

**ecp** Displays the current Encryption Control Protocol state.

#### **Example:**

```
list ecp  
ECP Options  
-----  
Data Encryption enabled  
Algorithm list: DESE-CBC  
DESE (Data Encryption Standard Encryption Protocol)
```



## Configuring PPP Interfaces (Talk 6)

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### Data Encryption Enabled/Disabled

Indicates whether data encryption is enabled or disabled on interface.

### Algorithm List

Displays the supported encryption algorithms. DES, as described by RFC 1969, is the only encryption algorithm currently supported.

**hdlc** Lists parameters related to the High-Level Data Link Control (HDLC) protocol. On PPP dial circuit interfaces, the “list hdlc” option is not available. For dial circuits, hardware data link parameters are a function of the base net rather than the PPP dial circuit. See “Chapter 54. Configuring and Monitoring Dial Circuits” on page 745 for more information.

### Example:

```
list hdlc
Encoding: NRZ
Idle State: Flag
Clocking: Internal
Cable type: V.35 DCE
Speed (bps): 6400

Transmit Delay Counter: 0
Lower DTR: Disabled
```

### Encoding:

HDLC transmission encoding scheme, either NRZ (non-return to zero) or NRZI (non-return to zero inverted).

### Idle State:

Bit pattern, either Flag or Mark, transmitted on the point-to-point link when the interface is not transmitting data.

### Clocking:

Interface clocking, either external or internal.

### Cable type:

Specifies the type of cable in use (RS-232, V.35, or V.36).

### Speed (bps):

The physical data rate of the interface. When clocking is internal, this is the data rate generated by the internal clock.

### Transmit Delay Counter:

Number of flags sent between frames.

### Lower DTR:

Enabled or Disabled. If Lower DTR is enabled, the router drops the DTR signal when a WAN Reroute alternate link is no longer needed. Dropping the DTR signal causes the modem to terminate the leased-line connection for the alternate link.

### Notes:

1. The **list hdlc** command is not supported on PPP dial circuit interfaces.
2. This command displays the Lower DTR state only if Lower DTR is supported for the configured cable type.
3. This command for a PPP interface on a HSSI adapter displays a subset of the HDLC parameters listed previously.

**ipcp** Lists the Internet Protocol control protocol options.

### Example: When RTP Header Compression is configured:

## Configuring PPP Interfaces (Talk 6)

```
list ipcp
IPCP Options
-----
IPCP Compression: RFC2508 TCP/UDP/RTP Format
TCP Compression Slots: 16
Non-TCP Compression Slots: 16
Max Period: 256
Max Time: 5
Max Header: 168
Start Port: 5004
End Port: 5515
Request an IP Address: No
Send Our IP Address: No
Remote IP Address to Offer if Requested: None
PPP 0 Config>
```

### Example: When VJ Header Compression is configured:

```
IPCP Options
-----
IPCP Compression: RFC1144 Van Jacobson Compression Slots: 16
Request an IP Address: No
Send Our IP Address: No
Remote IP Address to Offer if Requested: None
PPP 0 Config>
```

### IPCP compression

Indicates whether the PPP handler is to accept compressed IP headers.

### VJ or RTP Header Compression

PPP supports Van Jacobson TCP/IP header compression (RFC 1144) as well as IP/UDP/RTP Header compression (RFC2508). Enable either of these when the point-to-point link is running at a low baud rate. A value of VJ indicates RFC 1144 will be used. A value of RTP indicates RFC 2508 will be used.

### Request an IP Address

Indicates whether IPCP is configured to retrieve the local IP address for this PPP interface from the remote end of the link in the initial "Configure Request".

### Send Our IP Address

Indicates whether IPCP is configured to send the local IP address for this PPP interface to the remote end of the link in our initial "Configure Request". Some PPP implementations require this information.

### ipv6cp

Lists the Internet Protocol version 6 control protocol options.

#### Example:

```
list ipv6cp
IPv6CP Options
-----
Send Our IP Address: Yes
```

### Send Our IP Address

Indicates whether IPv6CP is configured to send the local IP address for this PPP interface to the remote end of the link in our initial "Configure Request". Some PPP implementations require this information.

### lcp

Lists the parameters and options for the Link Control Protocol.

#### Example:

```
PPP 7 Config>list lcp
```

## Configuring PPP Interfaces (Talk 6)

```
LCP Parameters
-----
Config Request Tries:          20  Config Nak Tries:          10
Terminate Tries:              10  Retry Timer:                3000

LCP Options
-----
Max Receive Unit:             1522  Magic Number:               Yes
Peer to Local (RX) ACCM:      A0000
Protocol Field Comp(PFC):     No    Addr/Cntl Field Comp(ACFC): No

Authentication Options
-----
Authenticate remote using:    none
Identify self as:             ibm
```

Link Control Protocol includes the authentication protocols used to authenticate the remote peer. If the authentication protocol is either CHAP or Microsoft PPP CHAP (MS-CHAP), the rechallenge interval is displayed.

### Example:

#### PPP 7 Config>list lcp

```
LCP Parameters
-----
Config Request Tries:          20  Config Nak Tries:          10
Terminate Tries:              10  Retry Timer:                3000

LCP Options
-----
Max Receive Unit:             1522  Magic Number:               Yes
Peer to Local (RX) ACCM:      A0000
Protocol Field Comp(PFC):     No    Addr/Cntl Field Comp(ACFC): No

Authentication Options
-----
Authenticate remote using:    MSCHAP or SPAP or CHAP or PAP [Listed in priority order]
CHAP Rechallenge Interval:    0
MSCHAP Rechallenge Interval: 0
Identify self as:             ibm
```

#### Config Request Tries:

Number of times that LCP sends configure-request packets to a peer station while attempting to open a PPP link.

#### Config Nak Tries:

Number of times that LCP sends configure-nak (“not acknowledged”) packets to a peer station while attempting to open a PPP link.

#### Terminate Tries:

Number of times that LCP sends terminate-request packets to a peer station to close a PPP link.

#### Retry Timer:

Number of milliseconds that elapse before packet transmission continues according to the number of times set by the “Config tries” parameter.

#### Max Receive Unit:

Displays the maximum information field (packet) size handled by the link.

#### Peer to Local (Rx) ACCM

Displays the characters that the peer must “escape” when transmitting packets to the router on asynchronous lines.

## Configuring PPP Interfaces (Talk 6)

### Magic Number:

Indicates whether the magic number loopback detection option is enabled.

### Protocol Field Comp (PFC):

Indicates whether the PFC option is enabled.

### Addr/Cntl Field Comp(ACFC):

Indicates whether ACFC is enabled.

### Authenticate remote using:

A list of enabled authentication protocols.

### Identify Self As:

The name set with the **set name** command.

**ncp** Lists the parameters for all Network Control Protocols.

### Example:

```
list ncp
NCP Parameters
-----
Config Request Tries:      20  Config Nak Tries:      10
Terminate Tries:          10  Retry Timer:           3000
```

### Config Request Tries:

Number of times NCP sends configure-request packets to a peer station while attempting to open a PPP link.

### Terminate Tries:

While awaiting a Terminate-Ack, the number of times NCP sends Terminate-Request before it closes a PPP link.

### Config Nak Tries:

Number of times NCP sends configure-nak (not acknowledged) packets to a peer station while attempting to open a PPP link.

### Retry Timer:

Number of milliseconds that elapse before timing out of NCP's transmission of configure-request packets (to open the link) and terminate-request packets (to close the link).

## LLC

Use the **LLC** command to access the LLC configuration environment (available only if APPN is included in the software load). See "LLC Configuration Commands" on page 233 for an explanation of each of these commands.

### Syntax:

llc

## Set

Use the **set** command to set HDLC parameters, LCP options and parameters, IPCP options, BCP options, and NCP parameters. "Parameters" are related to internal operations for such things as retry counts. "Options" are things that are negotiated with the other end.

### Notes:

1. Values immediately following the command option prompts reflect the current setting of that option. They are not always the default values illustrated in this chapter.
2. The **set hdlc** commands are not supported on PPP dial circuit interfaces.

### Syntax:

```

set
    bcp
    ccp options
    ccp algorithms
    hdlc...
    ipcp
    ipv6cp
    lcp...
    name...
    ncp...
  
```

**bcp** Sets the Bridging Control Protocol (BCP) parameters.

### Example:

```

set bcp
TINYGRAM COMPRESSION [no]:
  
```

### Tinygram Compression

Specifies whether or not Tinygram Compression is used. This option is useful for protocols that are prone to problems when bridged over low-speed (64 kbps and below) lines. These protocols add zeroes between the data and the frame checksum to pad the Protocol Data Unit (PDU) to the minimum size. Tinygram compression removes the zeroes and preserves the frame checksum at the transmitting end. At the receiving end, it restores the packet to the minimum length.

### ccp options

Prompts you for the configurable options of the compression algorithms. Some of the options may be modified later by PPP negotiations with the peer router on the WAN link. See “Configuring and Monitoring Data Compression” in *Using and Configuring Features* for more information.

### Example:

```

set ccp options
STAC: check mode (0=none, 1=LCB, 2=CRC, 3=Seq, 4=Ext) [3]?
STAC: # histories [1]?
  
```

### STAC: check mode (0=none, 1=LCB, 2=CRC, 3=Seq, 4=Ext)

STAC compressed datagrams normally include a check value used by the two ends of the link to recognize when a compressed packet has been lost or corrupted, and some action is needed to re-synchronize the sender’s and receiver’s histories.

**Note:** Failure to detect a bad packet can cause all subsequent data to be decompressed incorrectly.

This option sets the exact form of check value used. Choose one of the following:

- 0** None: No check value is used. Without a check value, there is no way to determine that a packet has been lost, out-of-sequence, or corrupted. Do not use this mode unless the underlying data link provides reliable, sequenced packet delivery.

## Configuring PPP Interfaces (Talk 6)

- 1 LCB: A “Longitudinal Control Byte” is used. This is a simple, 8-bit exclusive–OR checksum. *Its usage is strongly discouraged* because the receiver cannot detect a lost or an out-of-sequence packet, and the PPP frame checksum is a more reliable test of the packet’s integrity.
- 2 CRC: A 16-bit cyclic redundancy checksum is used. Although this is a better test of a packet’s integrity than the LCB, its use is still discouraged because the receiver still cannot use it to detect lost or out of sequence packets, and otherwise it becomes largely redundant with the frame checksum.
- 3 SEQ: An 8-bit sequence number is used (default). This is the preferred method of operation. If the number of histories is not 0, use of any other mode is strongly discouraged though another mode may be necessary for interoperability with certain non-RFC-compliant routers.
- 4 EXT: An extended mode that is similar to the sequence number mode, in that each packet includes a sequence number, but the compressed frame format is altered more radically. In extended mode, re-synchronization with a peer is performed differently than with the other modes; the signaling between the two nodes is based upon flags passed in the headers of compressed datagrams rather than distinct CCP control packets.

Extended mode is provided for compatibility with certain non- RFC-compliant implementations. It should be used only with clients that do not support mode 3.

### **STAC: # histories**

This sets the number of compression “contexts” or “histories” that are used by the STAC compression engine.

A nonzero value means that the compression engine maintains the specified number of histories where it keeps information about previous data sent in packets. This historical data is used to improve the effectiveness of the compression.

The receiver maintains a similar history and as long as the transmitter and receiver keep their histories in sync, the receiver can properly decompress the packets it receives. If the histories get out of sync, packets are discarded as unusable data. Normally, you should set the number of histories to 1 unless the link quality is very poor.

A value of zero means that each packet sent is compressed without regard to any past packets sent and may always be reliably decompressed by the receiver. However, because the compressor cannot exploit any information derived from examining prior packets, the effectiveness of the compression usually is not as good.

Some implementations support more than one history, subdividing the data stream into separate streams that are compressed independently. The router does not support the use of more than one history on a PPP link.

### ccp algorithms *list-of-algorithms*

Specifies an exact list of compression algorithms to use. The order of preference depends on the order of entry in the list. When MPPE is activated on the link, the order of the CCP algorithms is ignored and only Microsoft Point-to-Point Compression (MPPC) is used.

When the link negotiates compression with another node, it offers the entire list of protocols to the peer node in preference order. The peer node should select the first protocol it can use from the preference list. Enabling multiple protocols allows the peer to dictate which compression algorithm will be used on the link. If you need to avoid an algorithm, do not specify the algorithm in the list.

Specifying **none** disables the use of any protocol effectively disabling compression. The valid compression algorithms are:

#### STAC-LZS

The STAC-LZS algorithm as described in RFC 1974

**MPPC** The Microsoft Point-to-Point Compression algorithm as described in RFC 2118.

#### Example:

```
set ccp algorithms
PPP 6 Config>set ccp alg
Enter a prioritized list of compression algorithms (first is preferred),
all on one single line.
Choices (can be abbreviated) are:
STAC-LZS MPPC
Compressor list [STAC-LZS]? stac mppc
```

### hdlc cable *cable type*

Set the HDLC cable type (that is connected to the interface) to one of the following types:

- RS-232 DTE
- RS-232 DCE
- V35 DTE
- V35 DCE
- V36 DTE
- V36 DCE
- X21 DTE
- X21 DCE
- HSSI DTE
- HSSI DCE

Table 79 lists the cable types you can configure on the various adapters.

*Table 79. Cable types for 2216 Interfaces*

Adapter Type	Cable type
8-port EIA 232	RS-232 DTE and RS-232 DCE
6-port V.35/V36	V.35 DCE, V.35 DTE, V.36 DCE, or V.36 DTE
8-port X.21	X.21 DCE and X.21 DTE
1-port HSSI	HSSI DCE and HSSI DTE*

**Note:** When a HSSI DCE cable is used, the other device must also be configured to use a HSSI DCE cable.

**Example:** `set hdlc cable rs-232 dce`

## Configuring PPP Interfaces (Talk 6)

A DTE cable is used when you are attaching the router to some type of DCE device (for example, a modem or a DSU/CSU).

A DCE cable is used when the router is acting as the DCE and providing the clocking for direct attachment.

### **hdlc clocking** *external or internal*

To connect to a modem or DSU, configure external clocking and select the appropriate DTE cable with the **set hdlc cable** command. Use the **set hdlc speed** command to configure the line speed.

To connect directly to another DTE device, configure internal clocking, select the appropriate DCE cable with the **set hdlc cable** command, and configure the clocking/line speed with the **set hdlc speed** command.

**Default:** external

**Example:** `set hdlc clocking internal`

**Note:** The clocking type is not configurable when PPP is configured on a HSSI adapter. The clocking type is determined by the cable type. Internal clocking is used when the HSSI DCE cable type is configured and external clocking is used when the HSSI DTE cable type is configured.

### **hdlc encoding** *NRZ or NRZI*

Sets the HDLC transmission encoding scheme for an interface. Encoding may be set for NRZ (non-return to zero) or NRZI (non-return to zero inverted). NRZ is the more widely used encoding scheme while NRZI is used in some IBM configurations. The default value is NRZ.

**Note:** Encoding is set to NRZ for a PPP interface on a HSSI adapter and is not configurable.

**Example:** `set hdlc encoding nrz`

### **hdlc idle** *flag or mark*

Sets the data link idle state to either Flag or Mark.

The flag option provides continuous flags (7E hex) between frames.

The mark option puts the line in a marking state (OFF, 1) between frames.

**Note:** Idle is set to *flag* for a PPP interface on a HSSI adapter and is not configurable.

**Example:** `set hdlc idle flag`

### **hdlc speed** *value*

For internal clocking, use this command to specify the speed of the transmit and receive clock lines.

For external clocking, this command does not affect the operation of the WAN/serial line but it does set the speed that some protocols, such as IPX, use to determine routing cost parameters. You should set the speed to match the actual line speed. If the speed is not configured, the protocols assume a speed of 1 000 000 bps.

**Valid Values:**



## Configuring PPP Interfaces (Talk 6)

Internal Clocking: See Table 80

External Clocking: See Table 81

Table 80. Line Speeds When Internal Clocking is Used for 2216 Interfaces

Adapter Type	Speed Range
8-port EIA 232	9600 to 64 000 bps
6-port V.35/V.36	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps
8-port X.21	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps
1-port HSSI	22 368 000 bps or 44 736 000 bps

Table 81. Line Speeds When External Clocking is Used for 2216 Interfaces

Adapter Type	Speed Range
8-port EIA 232	2400 to 64 000 bps
6-port V.35/V.36	2400 to 2 048 000 bps
8-port X.21	2400 to 2 048 000 bps
1-port HSSI	1 544 000 bps to 52 000 000 bps

**Example: set hd1c speed 56 000**

### hdlc transmit-delay *value*

Sets the number of flags sent between frames. The purpose of this command is to slow the serial line so that it is compatible with older, slower serial devices at the other end.

The range is 0 to 15. The default is 0.

**Note:** If you configure a nonzero transmit delay for a PPP interface on the 8-port EIA-232E adapter, 6-port V.35/V.36 adapter, or 8-port X.21 adapter, you must configure the line speed using the **set hdlc speed** command.

**Example: set hdlc transmit-delay 15**

**ipcp** Sets all Internet Protocol Control Protocol options for that link.

### Example: Configuring RTP Header Compression

```
PPP 0 Config>set ipcp
IP COMPRESSION [yes]:
VJ or RTP Header Compression [RTP]:
  Max Period: [256]?
  Max Time: [5]?
  Max Header: [168]?
  RTP Start Port: [5004]?
  RTP End Port: [5515]?
  Number of TCP Slots: [16]?
  Number of Non-TCP Slots: [16]?
Request an IP address [no]:
Send our IP address [no]:
Note: unnumbered interface addresses will not be sent.
Interface remote IP address to offer if requested (0.0.0.0 for none) [0.0.0.0]?
```

### Example: Configuring VJ Header Compression

```
PPP 0 Config>set ipcp
IP COMPRESSION [yes]:
VJ or RTP Header Compression [VJ]:
  Number of TCP Slots: [16]?
Request an IP address [no]:
Send our IP address [no]:
Note: unnumbered interface addresses will not be sent.
Interface remote IP address to offer if requested (0.0.0.0 for none) [0.0.0.0]?
PPP 0 Config>
```

## Configuring PPP Interfaces (Talk 6)

### IPCP compression

Indicates whether the PPP handler is to accept compressed IP headers.

Setting this value to **yes** enables the compression option. Setting this value to **no** disables the option. The default setting is **no**.

### VJ or RTP Header Compression

PPP supports Van Jacobson TCP/IP header compression (RFC 1144) as well as IP/UDP/RTP Header compression (RFC 2508). Enable either of these when the point-to-point link is running at a low baud rate. A value of VJ indicates RFC 1144 will be used. A value of RTP indicates that RFC 2508 will be used.

The descriptions that follow depend on whether VJ or RTP was specified. If VJ, the only parameter configured is Number of TCP Slots.

#### Max Period

Specifies the maximum number of compressed headers that can be sent before a full header must be sent to refresh the header information stored in the slot.

**Valid Values:** 1 to 65 535

**Default Value:** 256

#### Max Time

Specifies the maximum number of seconds that compressed headers can be sent before a full header must be sent to refresh the header information stored in the slot.

**Valid Values:** 1 to 255

**Default Value:** 5

#### Max Header

Specifies the largest header (in bytes) that the compressor is expected to process.

**Valid Values:** 60 to 65 535

**Default Value:** 168

#### RTP Start Port

Specifies the start of the inclusive range of UDP ports used by RTP.

**Valid Values:** 5004 to 65 534

**Default Value:** 5004

#### RTP End Port

Specifies the end of the inclusive range of UDP ports used by RTP.

**Valid Values:** 5005 to 65 534

**Default Value:** 5515

#### Number of TCP Slots

Sets the number of TCP/IP headers that are saved when compressing TCP/IP headers.

**Valid Values:** 1 to 16

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**Default Value:** 16

### Number of Non-TCP slots

Sets the number of UDP/IP and RTP/UDP/IP headers that are saved when compressing TCP/IP headers.

**Valid Values:** 1 to 16

**Default Value:** 16

### Request an IP address

Specifies if the local IP address for this interface should be retrieved from the remote end of the link. You should set this option to **yes** if the other end of this link provides the IP address. This is a typical feature provided by ISPs (Internet Service Providers).

This interface will need to have a proper IP configuration for this requested address to become usable. Specifically, Dynamic-Address must be enabled on this interface.

**Note:** The next question, **Send Our IP address**, will not be displayed if **Request an IP address** is set to **yes**.

### Send Our IP address

Specifies whether or not to send the local IP address to the remote end of the link. You should set this option to **yes** if the other end of the link requires the IP address.

If this value is set to **yes**, IPCP will send the IP address of the PPP interface, if the interface is configured with a numbered IP address, (that is, the address does not begin with 0). If this option is set to **no** and the peer sends us a Configure NAK with 0.0.0.0 for the IP Address option, the 2216 will respond with the address of the PPP interface if it is configured with a numbered address.

### ipv6cp

Sets the IPv6 Control Protocol option for the link.

#### Example:

```
set ipv6cp  
Send Our IP address [no]:
```

### Send Our IP address

Specifies whether or not to send the local IPv6 address to the remote end of the link. Set this option to **yes** if the other end of the link requires the IPv6 address.

If this parameter is set to **yes**, IPv6CP will send the IPv6 address of the PPP interface, if the interface is configured with a numbered IPv6 address, (that is, the address does not begin with 0). If this option is set to **no** and the peer sends us a Configure NAK with ::/0 for the IPv6 address option, the 2216 will respond with the address of the PPP interface if it is configured with a numbered address.

### lcp options or parameters

Sets the Link Control Protocol options and parameters for the PPP link.

#### Example:

```
set lcp options  
Maximum Receive Unit (bytes) [2048]?  
Magic Number [yes]:  
Peer-to-Local Async Control Character Map (RX ACCM) [A0000] ?  
Protocol Field Compression (PFC) [no]?  
Addr/Cntl Field Compression (ACFC) [no]?
```

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### Maximum receive unit

Sets the maximum size of the information field that are transferred in a single datagram. The range is 576 to 4089 bytes. The default is 2048.

### Magic number

Specifies whether or not the magic number option is enabled. The magic number provides a way of detecting looped back links in serial line configurations. When this option is enabled, the link uses the system clock as a random number generator. The random numbers that are generated are referred to as magic numbers.

When the LCP receives a Configure Request with a magic number present (i.e., the magic number option is enabled), the received magic number is compared with the magic number in the last Configure-Request sent to the peer. If the two magic numbers are different, the link is not considered looped back. If the two numbers are the same, the PPP handler attempts to bring the link down and up again to renegotiate magic numbers.

Setting this value to Yes enables the magic number option. Setting this value to No disables the option. The default setting is Yes.

### Async Control Character Map

Indicates which characters that the peer must “escape” when transmitting packets to the router on asynchronous lines. This allows certain sensitive ASCII control characters, such as XON and XOFF, to be transmitted transparently over the link.

Specify a 32-bit bit mask in hexadecimal. If a bit in position 'N' of the mask is set, the corresponding ASCII character 'N' must be escaped (the LSB is bit number 0, corresponding to the ASCII NUL character).

The default value for this option is '0A0000', indicating that XON and XOFF (control-Q and control-S) need to be escaped. This is for the benefit of modems that use XON/XOFF to perform software handshaking. If this is not an issue, then it is recommended that you change the ACCM to zero (no characters escaped).

LCP is always willing to negotiate the ACCM, even on synchronous lines, and the **list lcp** command in the PPP monitoring process will display the negotiated value. However, synchronous lines employ a “bit-stuffing” mechanism rather than an “escaping” mechanism, so the ACCM is not normally meaningful on synchronous lines. It may be meaningful if the router is connected to a modem that performs sync-to-async conversion, in which case its value should reflect the requirements of the attached modem on the asynchronous side.

### Addr/Cntl Field Compression (ACFC)

Specifies whether the peer can employ address and control field compression.

If the ACFC option is successfully negotiated by LCP, it means that the Address and Control field bytes which start off each packet may be omitted in the datagrams sent back and forth on the link. These bytes are always 0xFF 03, so there is no real information provided by them, and enabling ACFC means that the datagrams that are transmitted will be two bytes shorter.

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To be precise, if you enable ACFC, you are indicating a receive-side capability. If you enable ACFC and LCP successfully negotiates it, the other end can employ ACFC in the packets it transmits to the local end (most PPP options work like this). The local end will only transmit packets *without* the address and control fields if the other end also indicates its ability to handle such packets.

Enabling ACFC does not obligate the other end to send packets without the address and control fields, even if it accepts the option. Enabling ACFC merely tells the peer that it optionally *may* use ACFC, and the router will be able to handle the incoming packets. If the peer indicates that it can handle ACFC, then the router always performs ACFC on the packets it transmits regardless of whether ACFC is enabled locally.

LCP packets always are sent with address and control fields present. This guarantees that LCP packets will be recognized even if there is a loss of link synchronization.

### Protocol Field Compression (PFC)

Specifies whether the peer is to employ protocol field compression.

When you specify “yes”, if the PFC option is negotiated successfully by LCP, the leading zero byte may be omitted from the “Protocol” field for those protocol values in the range '0x0000'–'0x00FF', for a one byte savings in the packets being transmitted. This range includes the majority of layer-3 protocol datagrams.

PPP protocol values are all assigned such that the upper byte of the protocol is an even value and the lower byte is an odd value (a limited use of the more generalized mechanism described by the ISO 3309 extension mechanism for address fields). Thus, the receiver can readily detect when the leading byte of a protocol value has been omitted (the first byte of the protocol field is odd rather than even), so there is no ambiguity interpreting frames in the presence of PFC.

PFC, like ACFC, is a receive side capability and the previous description of ACFC applies to PFC.

#### Example:

```
set lcp parameters
Config tries [20]?
NAK tries [10]?
Terminate tries [10]?
Retry timer (mSec) [3000]?
```

**Note:** The value immediately following the command option prompt is the current setting of that option. It is not always the default value illustrated in this chapter.

#### Retry timer

Sets the amount of time in milliseconds that elapses before LCP's transmission of configure-request (to open the link) and terminate-request (to close the link) packets is timed out. Expiration of this timer causes a timeout and the halting of configure-request and terminate-request packet transmission. The range is 200 to 30000 milliseconds. The default setting is 3000 milliseconds.

#### Config tries

Sets the number of times that LCP sends configure-request packets

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to a peer station to establish the opening of a PPP link. The default value is 20. The range is 1 to 100.

The retry timer starts after the first configure-request packet is transmitted. This is done to guard against packet loss.

### NAK tries

Sets the number of times that LCP sends configure-nak (nak = not acknowledged) packets to a peer station while attempting to open a PPP link. The default value is 10. The range is 1 to 100.

LCP sends configure-nak packets upon receiving configure-request packets with some unacceptable configuration options. These packets are sent to refuse the offered configuration options and to suggest modified, acceptable values.

### Terminate tries

Sets the number of times that LCP sends terminate-request packets to a peer station to close a PPP link. The default value is 10. The range is 1 to 100.

The retry timer starts after the first terminate-request packet is transmitted. This is done to guard against packet loss.

**name** Sets the name that the router uses when responding to authentication requests from another router.

### Notes:

1. While the “case” that you use for names and passwords sent to the peer on the link are preserved for this product, interoperability with other vendor products is easier if all names and passwords are entered in *lowercase*.
2. Other implementations may not handle names with the same maximum length as supported in this product. The only indication is a message from the authenticator stating that there is a bad name. If you receive this type of message, try shortening the routerid.
3. This command sets the name of the local router. Use the talk 6 **add ppp-user** command at the Config> prompt to add each remote user to the local data base, if you want to use the local data base to track the remote users. The alternative is to configure the external AAA authentication server that is described in the chapter “Using Local or Remote Authentication” in *Using and Configuring Features* .

**Note:** The external AAA authentication server cannot be used by MS-CHAP.

### Example:

```
set name
PPP 7 Config>set name
Enter Local Name: [ ]? newyork
Password:
Enter password again:
PPP Local Name = newyork
```

### ncp parameters

Sets the basic operational parameters for most NCPs.

**Note:** Although you access this command through a particular interface, this command will reset the parameters for all PPP interfaces.

### Example:

```
set ncp parameters
Config tries [20]
NAK tries [10]?
Terminate tries [10]?
Retry timer (mSec) [3000]?
```

### Config tries

Sets the number of configure-request packets sent by NCP to a peer station to attempt to open a PPP link. The range is 1 to 100. The default is 20.

This action indicates the desire to open an NCP connection with a specified set of configuration options. The retry timer starts after a configure-request packet is transmitted. This is done to guard against packet loss.

### NAK tries

Sets the number of configure-nak (nak = not acknowledged) packets that NCP sends to a peer station while attempting to open a PPP link. The range is 1 to 100. The default value is 10.

Upon receiving configure-request packets with some unacceptable configuration options, NCP sends configure-nak packets. These packets are sent to refuse the offered configuration options and to suggest modified, acceptable values.

### Terminate tries

Sets the number of terminate-request packets sent by NCP to a peer station to close a PPP link. The range is 1 to 100. The default value is 10.

This action indicates the desire to close an NCP connection. The retry timer is started after a terminate-request packet is transmitted. This is done to guard against packet loss.

### Retry timer

Sets the amount of time, in milliseconds, that elapses before NCP's transmission of configure-request (to open the link) and terminate-request (to close the link) packets is timed out. Expiration of this timer causes a timeout and the halting of configure-request and terminate-request packet transmission. The range is 200 to 30000 milliseconds. The default is 3000 milliseconds.

---

## Accessing the Interface Monitoring Process

To access the PPP interface monitoring process, do the following:

1. Enter **interface** at the + prompt to display a list of configured interfaces.
2. Enter **network** followed by the number of the PPP interface.

```
+ network 2
PPP>
```

---

## Point-to-Point Monitoring Commands

This section summarizes and then explains the Point-to-Point monitoring commands. Enter the commands at the PPP> prompt. Table 82 on page 618 shows the commands.

**Note:** The options available for these commands depend on what protocols are available in the router software. For example, when the router software

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(image) does not contain APPN support, the **list isrcp**, **list isr**, **list hprcp**, **list hpr**, and **llc** commands are not available.

Table 82. Point-to-Point Monitoring Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Clear	Clears all statistics from point-to-point interfaces.
List	Displays information and counters related to the point-to-point interface and PPP parameters and options.
LLC	Displays the LLC monitoring prompt.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

### Clear

Use the **clear** command to clear all statistics from point-to-point interfaces.

#### Syntax:

**clear** all

**Example:** clear all

### List

Use the **list** command to display information and counters related to the point-to-point interface and PPP parameters and options.

#### Syntax:

**list** all  
cbcp - callback cp  
control  
errors  
interface  
lcp - PPP link CP  
pap - PAP Authentication CP  
chap - CHAP Authentication CP  
mschap - MS-CHAP Authentication CP  
ecp - Encryption Control Protocol  
edp - Encrypted packet statistics  
mppe - Microsoft PPP Encryption (MPPE)  
spap - SPAP Authentication CP  
ccp - PPP Compression CP  
cdp - PPP compression  
compression - PPP compression  
bcp - Bridging (ASRT) CP  
brg - Bridging (ASRT)



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stp - Spanning Tree Protocol

nbc - NetBios

nbfc - NetBios Frame

ipc - Internet Protocol CP

ip - Internet Protocol

ip6c - Internet Protocol version 6 CP

ip6 - Internet Protocol version 6

ipxc - Novell IPX CP

ipx - Novell IPX

atc - AppleTalk (Phase 2) CP

ap2 - AppleTalk (Phase 2)

dn - DECnet IV CP

dn - DECnet IV

osic - ISO's OSI CP

osi - ISO's OSI

bvc - Banyan VINES CP

vines - Banyan VINES

isrc - APPN ISR CP

isr - APPN ISR

hprc - APPN HPR CP

hpr - APPN HPR

**all** Lists all information and counters related to the point-to-point interface and PPP options and parameters. The output displayed for this command is a combination of the displays from all of the individual **list item** commands.

**Note:** If a network control protocol is not available on an interface, a message is displayed indicating that no protocol or statistics information is available for that network control protocol's list commands.

**cbcp** Lists statistics for the Callback Control protocol.

### Example: list cbcp

CBCP Statistics	In	Out
-----	---	-----
Packets:	0	0
Octets:	0	0
Callback attempts:	0	
Successful callbacks:	0	

### Packets

Indicates the total number of CBCP packets transmitted (out) and received (in) over the current point-to-point interface.

### Octets

For CBCP frames, indicates the total number of bytes in Octets transmitted and received over the current point-to-point interface.

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### Callback attempts

The number of CBCP callbacks attempted, including those in progress.

### Successful callbacks

The number of successful callbacks completed.

### control

Lists negotiated options or other state information for a control protocol.

ccp  
ecp  
lcp  
bcp  
nbc  
nbc  
ipcp  
ipxcp  
atcp  
dn  
osicp  
bvc  
isrcp  
hprcp

### Examples of the List Control CCP Command

#### Example for STAC-LZC:

```
list control ccp
CCP State:           Open
Previous State:      Ack Sent
Time Since Change:   264 hours, 56 minutes and 58 seconds

Compressor:  STAC-LZS histories 1, check_mode SEQ
Decompressor: STAC-LZS histories 1, check_mode SEQ

MPPE : Negotiated 40 bit stateful
```

#### Example for MPPC:

```
list control ccp
CCP State      :      Open
Previous State :      Listen
Time Since Change: 167 minutes

Compressor : none
Decompressor : none

MPPE : Negotiated 40 bit stateful
```

### Definitions of Terms in the List Control CCP Example

#### CCP state

The current state of the point-to-point link. If “Open”, then compression was successfully negotiated on this link. If not open, compression is not running on the link. It will also show as “Open” if MPPE has been successfully negotiated.

#### Previous State

State of the point-to-point link before the state displayed in the current state field.

### Compressor

Shows which compressor was negotiated and the options it is using.

### Decompressor

Shows which decompressor was negotiated and the options it is using.

**MPPE** MPPE options negotiated. See the talk 6 **enable mppe** command for descriptions of these parameters and Microsoft Point-to-Point Encryption (MPPE) in the chapter “Using and Configuring Encryption Protocols” in *Using and Configuring Features* for more information.

### Example of the List Control ECP Command

#### Example:

```
PPP x>list control ecp
```

```
ECP State:                Open
Previous State:           Ack Sent
Time Since Change:       16 minutes and 40 seconds
```

```
Local (transmit) encrypter: DES
Remote (receive) encrypter: DES
```

### Definitions of Terms in the List Control ECP Example

#### ECP State:

The current state of the point-to-point link. If “Open” then encryption was successfully negotiated on this link. If not “Open”, encryption is not running on the link.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

#### Previous State:

The state of the point-to-point link before the state displayed in the current state field.

#### Time Since Change:

The elapsed time between the above two state changes.

#### Local (transmit) encrypter:

This encryption algorithm is used for encrypting the data being sent on this PPP interface.

#### Remote (receive) encrypter:

The encryption algorithm is used for decrypting the received data on this interface.

### Example of the List Control LCP Command

#### Example:

```
list control lcp
```

```
Version:                1
Link phase:              Establishing connection (LCP)
LCP State:               Listen
Previous State:          Req Sent
Time Since Change:      1 minute and 57 seconds
Remote Username:        - No Authentication -
```

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```
Last Identification Rx'd
Time Connected:          - No Connection -

LCP Option               Local               Remote
-----
Max Receive Unit:        2048                1500
Async Char Mask:         FFFFFFFF           FFFFFFFF
Authentication:          None                None
Magic Number:            7A8CBFD7           None
Protocol Field Comp:     No                  No
Addr/Cntl Field Comp:    No                  No
32-Bit Checksum:         No                  No
```

### Definitions of Terms in the List Control LCP Example

#### Version

Displays the current version of the Point-to-Point Protocol.

#### Link phase

Displays the current activity on the link. This can have one of the following values:

**Dead** There is no activity on the link; the interface is down.

**LCP** The link is in LCP negotiation. This state occurs when first bringing up an interface. The interface may be in self-test at this time.

#### Authenticate

The link is performing initial authentication.

**ECP** The link is negotiating an ECP encryption algorithm.

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See the CONFIG process **load** command in *Nways Multiprotocol Access Services Software User's Guide*.

The use of multiple encryption (using encryption at both the IP Security Layer and at the Frame Relay or PPP data-Link Layer) within the router is restricted by U.S.A. Government export regulations. It is only supported in software loads that are under strict export control (software loads that support RC4 with 128 bit keys and Triple DES).

**Ready** Link is operating normally. NCPs can negotiate and data traffic associated with can flow after successful NCP negotiation.

#### Terminate

The link is being shut down.

#### LCP State

Displays the current state of the point-to-point link. These states include the following:

**OPEN** - Indicates that a connection has been made and data can be sent. The retry timer does not run in this state.

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**CLOSED** - Indicates that the link is down and no attempt is being made to open it. In this state, all connection requests from peers are rejected.

**LISTEN** - Indicates that the link is down and no attempt is being made to open it. In contrast to the **CLOSED** state, however, all connection requests from peers are accepted.

**REQUEST-SENT** - Indicates that an active attempt is being made to open the link. A Configure-request packet has been sent but a Configure-Ack has not yet been received nor has one been sent. The retry timer is running at this time.

**ACK-RECEIVED** - Indicates that a Configure-request packet has been sent and a Configure-Ack packet has been received. The retry timer is still running since a Configure-Ack packet has not been transmitted.

**ACK-SENT** - Indicates that a Configure-Ack packet and a Configure-request packet have been sent but a Configure-Ack packet has not been received. The retry timer always runs in this state.

**CLOSING** - Indicates that an attempt is being made to close the connection. A Terminate-request packet has been sent but a Terminate-Ack packet has not been received. The retry timer is running in this state.

### **Previous State**

Displays the state of the point-to-point link prior to the state displayed in the Current state field. These states are the same as those described in the Current state field.

### **Time since change**

Displays the amount of time that has elapsed since the last link state change.

### **Remote Username**

When authentication is required on the link, this field shows the name that the peer supplied.

### **Last Identification Rx'd**

An optional packet type that is defined for LCP is an "Identification" packet. The contents of this packet are undefined but are normally expected to be a human-readable string provided by the peer to give some identifying information such as a name, manufacturer, model number, or other information the manufacturer wishes to provide. If the router receives such a packet, the contents of the last such packet received are displayed here.

### **Time Connected**

Indicates how long the peer has been connected on this link.

### **LCP Option**

These fields indicate the values of options that have been negotiated with the peer when LCP is in the Open state. When LCP is not open, these values represent initial defaults or configured values that will be used in subsequent LCP negotiations.

### **Max Receive Unit**

Indicates the maximum length for the packet size that the local and

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remote ends can transmit. This is the maximum length of the payload portion of a PPP packet and it does not include PPP header and trailer bytes.

When LCP is in an Open state, the values indicate the lengths that have been negotiated with the peer. The router does not support differing MRU lengths for the peer and local end, so these values will be the same.

### Async Character Mask

This indicates the asynchronous control character mask that has been negotiated. The router accepts ACCM negotiation even on synchronous lines, although this does not affect the actual packet data sent. See the **set lcp options** command on page 613 for more information about the ACCM.

### Authentication

Indicates which authentication protocol, if any, each end of the link requires. Multiple protocols may be available at each end; this value indicates which protocol the units agreed to use.

### Magic number

Displays the current magic number being used for both the local and remote ends of the link for loopback detection.

### Protocol compression

Indicates whether PFC has been negotiated.

### Address/Control compression

Indicates whether ACFC has been negotiated.

### 32-bit checksum

Not currently supported. PPP will reject this option if it is received.

## Example of the List Control BCP Command

### Example:

```
list control bcp
BCP State:          Closed
Previous State:     Closed
Time Since Change:  5 hours, 25 minutes and 3 seconds

BCP Option          Local          Remote
Tinygram Compression  DISABLED        DISABLED
Source-route Info:
Remote side does not support source-route bridging
```

### Definitions of Terms in the List Control BCP Example

The BCP State fields are the same as those described under the **list control lcp** command.

### Tinygram Compression

Displays whether or not Tinygram Compression is enabled or disabled on the local and remote ends of the link.

### Source-route Info

Displays whether or not source route bridging is enabled for the local and remote ports that correspond to this interface.

### Example of the List Control NBFCP Command

#### Example:

```
list control nbfcf
NBFCP State:          Closed
Previous State:      Closed
Time Since Change:   4 hours, 5 minutes and 58 seconds

NetBIOS Frame Control Protocol Info:
Local MAC Address = 0x000000000000
Remote MAC Address = 0x444553540000
Remote NetBIOS Names: (0)

Remote Peer Class:   0
Remote Peer Version Major: 0
Remote Peer Version Minor: 0
```

### Definitions of Terms in the List Control NBFCP Example

The NBFCP State fields are the same as those described under the **list control lcp** command.

#### Local MAC Address

The Local MAC Address is the MAC Address that is used by the Win 95/NT Dial-Up Networking client. It is a pseudo-random number, or a Locally Administered Address (LAA), if you configured an LAA in the client.

#### Remote MAC Address

The Remote MAC Address is the MAC Address that the 2216 DIALS Server has assigned to this client for use on the LAN.

#### Remote NetBIOS Name

The list of NetBIOS names of LAN resources to which the client has requested access.

#### Remote Peer

The Remote Peer Class, Version Major, and Version Minor is the information passed back to the 2216 by the NBFCP Peer Information option.

### Example of the List Control IPCP Command

#### Example:

```
list control ipcp
IPCP State:          Listen
Previous State:      Closed
Time Since Change:   3 minutes and 40 seconds

IPCP Option          Local          Remote
-----
IP Address            0.0.0.0          None
TCP Compression Slots 16              None
Non-TCP Compression Slots 16            None

DNS servers obtained from remote:
Primary DNS:  None
Secondary DNS: None

DHCP State:          BOUND
Lease Server:        10.0.0.111
Leased IP Address:   10.0.0.152
Lease Time:          4 minutes and 0 seconds
Renewal Time:        2 minutes and 0 seconds
Rebind Time:         3 minutes and 30 seconds
Lease Time Elapsed: 1 second
```

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Lease Time Remaining: 3 minutes and 59 seconds  
DHCP Client ID: 0100120B0000

### Definitions of Terms in the List Control IPCP Example

The IPCP state fields are the same as those described under the **list control lcp** command.

#### IP Address:

Indicates this interface's configured or negotiated IP address (Local) and the negotiated address of the remote (Remote), if any.

#### TCP Compression Slots

These slots are for TCP traffic only.

#### Non-TCP Compression Slots

These slots are for Non-TCP traffic only.

#### DNS servers obtained from remote

Indicates the IP addresses of the Domain Name Servers (DNS) provided by the remote side.

#### DHCP State

This is the Proxy DHCP as described in RFC 1541.

#### Lease Server

The server from which the lease was acquired.

#### Leased IP address

The address leased to the client. This address should be equivalent to the "Remote IP Address" listed above.

#### Lease Time

Length of lease from the DHCP server for this address. When "Lease Time Elapsed" equals this time, the lease will be expire and the IPCP connection closed.

#### Renewal Time

Time after which Proxy DHCP attempts to extend this lease from the server. When "Lease Elapsed Time" equals this time, Proxy DHCP attempts to renew the lease, resetting the "Lease Time," "Lease Elapsed Time," and "Lease Time Remaining," if successful.

#### Rebind Time

Time before Proxy DHCP attempts to obtain a new lease from any configured DHCP server. When "Lease Elapsed Time" equals this time, Proxy DHCP attempts to obtain a new lease, resetting the "Lease Time," "Lease Elapsed Time," and "Lease Time Remaining," if successful.

#### Leased Time Elapsed

Time elapsed for this lease. This is not necessarily the time for this particular dial-in session, as the lease may have been renewed. When the lease is renewed, this timer is set back to 0.

#### Leased Time Remaining

Time remaining for this lease. This parameter is equal to "Lease Time" minus "Lease Time Elapsed."

#### DHCP client ID

A unique ID for this client (dial-in user). All DHCP messages are identified to and from the DHCP server by this client ID.



### Example of the List Control IPXCP Command

#### Example:

```
list control ipxcp
IPXCP State:      Closed
Previous State:   Closed
Time Since Change: 2 hours, 9 minutes and 9 seconds
```

The IPXCP state fields are the same as those described under the **list control lcp** command.

#### Example:

```
list control atcp
ATCP State:      Closed
Previous State:   Closed
Time Since Change: 6 hours, 27 minutes and 7 seconds

AppleTalk Address Info:
Common network number = 12
Local node ID = 49
Remote node ID = 76
```

### Definitions of Terms in the List Control ATCP Example

The ATCP State fields are the same as those described under the **list control lcp** command.

#### Common Network Number

Network number of the two ends of the point-to-point link. (You must statically configure both ends of the link to have the same network number.)

#### Local Node ID

Unique node number of the local end of the link.

#### Remote Node ID

Unique node number of the remote end of the link.

#### Example:

```
list control dnpc
DNCP State:      Closed
Previous State:   Closed
Time Since Change: 2 hours, 2 minutes and 58 seconds
```

The DNCP state fields are the same as those described under the **list control lcp** command.

#### Example:

```
list control osicp
OSICP State:     Closed
Previous State:   Closed
Time Since Change: 6 hours, 28 minutes and 32 seconds
```

The OSICP State fields are the same as those described under the **list control lcp** command.

#### Example:

```
list control bvcp
BVCP State:      Open
Previous State:   Ack Sent
Time Since Change: 403 hours, 49 minutes and 2 seconds
```

The BVCP State fields are the same as those described under the **list control lcp** command.

## Monitoring PPP Interfaces (Talk 5)

**Note:** The command word **bvcp** and the acronym BVCP stand for the Banyan VINES Control Protocol (BVCP).

### Example of the List Control ISRCP Command

**Example:**

```
list control isrcp
APPN ISRCP State:      Open
Previous State:       Ack Rcvd
Time Since Change:    1 hour, 48 minutes and 5 seconds
```

The APPN ISR control protocol (ISRCP) state fields are the same as those described under the list control lcp command. **Example of the List Control HPRCP Command**

**Example:**

```
list control hprcp
APPN HPRCP State:      Open
Previous State:       Ack Rcvd
Time Since Change:    1 hour, 48 minutes and 10 seconds
```

The APPN HPR control protocol (HPRCP) state fields are the same as those described under the list control lcp command

**error** Lists information related to all error conditions tracked by the PPP software.

**Example:**

list error		
Error Type	Count	Last One
-----	----	-----
Bad Address:	0	0
Bad Control:	0	0
Unknown Protocol:	0	0
Invalid Protocol:	0	0
Config Timeouts:	0	0
Terminate Timeouts:	0	0

### Bad address

Indicates the total number of bad addresses encountered over the point-to-point link. "Bad addresses" refers to the HDLC framing byte at the start of the packet.

### Bad control

Indicates the total number of bad control packets encountered over the point-to-point link. "Bad control" refers to the 0x03 prefix on HDLC encapsulated PPP packets ("UI" value that follows the 0xFF).

### Unknown protocol

Indicates the total number of unknown protocol packets encountered by the current link.

### Invalid protocol

Indicates the total number of invalid protocol packets encountered by the current link.

### Config timeouts

Indicates the total number of configuration timeouts experienced by the link.

### Terminate timeouts

Indicates the total number of link termination timeouts experienced by the link.

## interface

Lists PPP interface statistics.

**Example:**

## Monitoring PPP Interfaces (Talk 5)

```
list interface
Interface Statistic      In      Out
-----
Packets:                 0       0
Octets:                  0       0
```

### Packets

Indicates the number of packets received and transmitted on this interface.

### Octets

Indicates the number of octets received and transmitted on this interface.

**lcp** Lists statistics for the Link Control Protocol.

### Example:

```
list lcp
LCP STATISTIC          IN      OUT
-----
PACKETS:               42      42
OCTETS:               1260    1260
CFG REQ:               0       0
CFG ACK:               0       0
CFG NAK:               0       0
CFG REJ:               0       0
TERM REQ:              0       0
TERM ACK:              0       0
ECHO REQ:              21      21
ECHO RESP:             21      21
DISC REQ:              0       0
CODE REJ:              0       0
```

### Packets

Indicates the total number of LCP packets transmitted (out) and received (in) over the current point-to-point interface.

### Octets

For LCP frames, indicates the total number of bytes in octets transmitted and received over the current point-to-point interface.

### CFG REQ

Indicates the total number of configure-request LCP packets transmitted and received over the current point-to-point interface.

### CFG ACK

Indicates the total number of configure-ack (acknowledged) LCP packets transmitted and received over the current point-to-point interface.

### CFG NAK

Indicates the total number of configure-nak (not acknowledged) LCP packets transmitted and received over the current point-to-point interface.

### CFG REJ

Indicates the total number of configure-reject LCP packets transmitted and received over the current point-to-point interface.

### TERM REQ

Total number of terminal request LCP packets transmitted and received over the current point-to-point interface.

### TERM ACK

Total number of terminal ack LCP packets transmitted and received over the current point-to-point interface.

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### ECHO REQ

Indicates the total number of echo-request LCP packets transmitted and received over the current point-to-point interface.

### ECHO RESP

Indicates the total number of echo-response LCP packets transmitted and received over the current point-to-point interface.

### DISC REQ

Indicates the total number of discard-request LCP packets transmitted and received over the current point-to-point interface.

### CODE REJ

Indicates the total number of code-reject LCP packets transmitted and received over the current point-to-point interface.

**pap** Lists statistics for the Password Authentication Protocol.

#### Example:

```
list pap
PAP Statistics          In          Out
-----
Packets:                0            0
Octets:                 0            0
Requests:               0            0
Acks:                   0            0
Naks:                   0            0
```

#### Packets

The total number of PAP packets sent or received.

#### Octets

The number of bytes of data that were sent or received in those packets.

#### Requests

The number of PAP "Request" packets sent or received. These are the packets which contain the PAP name/password pairs.

**Acks** The number of Acks (success replies) sent or received for the PAP requests (for example, if the peer sends a valid Request packet, the router replies with an Ack).

**Naks** The number of Naks sent or received for the PAP requests (for example, if the peer sends an invalid Request packet, the router replies with a Nak).

**chap** Lists statistics for the Challenge-Handshake Authentication Protocol.

#### Example:

```
list chap
CHAP Statistics        In          Out
-----
Packets:               0            0
Octets:                0            0
Challenges:            0            0
Responses:             0            0
Successes:             0            0
Failures:              0            0
```

#### Packets

The total number of CHAP packets sent or received.

#### Octets

The number of bytes of data that were sent or received in the packets.

### Challenges

The number of CHAP “Challenge” packets sent or received. A CHAP Challenge packet includes a randomly generated encryption key and is a demand on the peer to generate a suitable response based on that key and on stored password information.

### Responses

The number of CHAP “Response” packets sent or received. A Response packet contains a peer’s answer to a “Challenge” request.

### Successes/Failures

The number of Success or Failure packets sent or received. A unit sends out a Challenge packet and waits for the peer’s Response reply. It then examines the Response packet and sends a Success or Failure packet to indicate whether the Response was valid.

These counters reflect the number of Success or Failure packets sent. A peer gets several tries to respond successfully before authentication is considered to have failed.

### mschap

Lists MS-CHAP statistics for each direction.

#### Packets

Total number of MS-CHAP packets.

#### Octets

Total number of bytes contained in MS-CHAP packets.

#### Challenges

Number of MS-CHAP challenge packets.

#### Responses

Number of MS-CHAP response packets.

#### Successes

Number of MS-CHAP success packets.

#### Failures

Number of MS-CHAP failure packets.

#### Failure: Restricted Hours

Number of failure packets sent due to the PPP user’s attempt to access the 2216 outside of that user’s permitted hours. This counter is not supported and will always be 0.

#### Failure: Account Disabled

Number of failure packets sent because the PPP user’s ID has been disabled at the 2216.

#### Failure: Password Expired

Number of failure packets sent because the PPP user’s password has expired.

#### Failure: No Dialin Permission

Number of failure packets sent because the PPP user is not authorized to dial in to this 2216.

#### Failure: Authentication

Number of failure packets sent because the PPP user’s credentials (ID or password) are not known to the 2216.

## Monitoring PPP Interfaces (Talk 5)

### Failure: Change Password

Number of failure packets sent as a result of error encountered while processing the Change Password packet.

### Change Password

Number of change password packets. The router will never send a change password packet; therefore, the outbound counter will always be 0.

**ecp** Lists statistics for ECP (encryption control protocol) packets sent or received on the interface.

### Example:

```
PPP x>list ecp
```

ECP Statistic	In	Out
-----	--	---
Packets:	2	2
Octets:	26	26
Reset Reqs:	0	0
Reset Acks:	0	0
Prot Rejects:	0	-
Local (transmit) encrypter: DES		
Remote (receive) encrypter: DES		

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### Packets

Indicates the total number of ECP packets transmitted (out) and received (in) over the current point-to-point interface.

### Octets

Indicates the total number of bytes transmitted and received in the ECP packets.

### Reset Reqs

Indicates the number of Reset requests transmitted and received on this interface. A Reset Request will be sent whenever ECP discard an EDP packet.

**Note:** Because DES, the only supported encryption algorithm, does not send reset requests this number will be zero.

### Reset Acks

Indicates the reset acknowledgments transmitted and received on this interface. A Reset Ack packet will be sent for every Reset Request packet received.

**Note:** Because DES, the only supported encryption algorithm, does not send any Reset Requests this number will be zero.

### Prot Rejects

Indicates the total number of protocol reject packets transmitted and received over the current point-to-point interface.

### Local (transmit) encrypter

This encryption algorithm will be used to encrypt the data being sent on this point-to-point interface.

### Remote (receive) encrypter

This encryption algorithm will be used to decrypt the received data on this point-to-point interface.

## Monitoring PPP Interfaces (Talk 5)

**edp** Lists statistics associated with the ECP-encrypted packets being sent or received on the interface.

### Example:

```
PPP x>list edp
```

Encryption Statistic	In	Out
-----	--	---
Packets:	20	30
Octets:	29164	44790
Encrypted Octets:	29280	44880
Discarded Packets:	0	0
Prot Rejects:	0	-

**Note:** Encryption support is optional and must be added to your software load using the **load add** command. See “Load” on page 95.

### Packets

Indicates the total number of IP packets transmitted (out) and received (in) over the current point-to-point interface.

### Octets

Indicates the total number of octets of data bytes transmitted and received over the current IP connection.

### Encrypted Octets

Indicates the number of encrypted octets transmitted or received on this interface.

### Discarded Packets

Indicates the number of packets that were discarded because they could not be successfully decrypted.

### Prot Rejects

Indicates the total number of protocol reject packets transmitted and received over the current point-to-point interface.

**mppe** Displays encryption data statistics for Microsoft PPP Encryption (MPPE) configuration.

### Example:

```
list mppe
MPPE Statistic      In      Out
-----
Encrypted Octets :   0         0
Encrypted Packets :   0         0
Discarded Packets :   0         0
```

**spap** Lists statistics for the Shiva Password Authentication Protocol.

### Example:

```
list spap
SPAP Statistic      In      Out
-----
Packets:            0         0
Octets:             0         0
Requests:           0         0
Acks:               0         0
Naks:               0         0
Dialbacks:          0         0
PleaseAuthenticates: 0         0
Change Passwords:   0         0
Alerts:             0         0
MCCP Call Reqs     0         0
MCCP Callbacks     0         0
MCCP ACKs          0         0
MCCP NAKs          0         0
```

### Packets

The total number of SPAP packets sent or received.

## Monitoring PPP Interfaces (Talk 5)

### Octets

The number of bytes of data that were sent or received in those packets.

### Requests

The number of SPAP "Request" packets sent or received. These are the packets which contain the SPAP name/password pairs.

### Acks

The number of Acks (success replies) sent or received for the SPAP requests (for example, if the peer sends a valid Request packet, the router replies with an Ack).

### Naks

The number of Naks sent or received for the SPAP requests (for example, if the peer sends an invalid Request packet, the router replies with a Nak).

### Dialbacks

The number of times a user:

- Requested a callback (roaming callback) and it was granted.
- Dialed-in and they were configured for required callback and dialed back at the predetermined number stored in the user profile.

### Please Authenticates

The number of SPAP please authenticate packets that have been sent or received on this interface. An SPAP please authenticate packet is sent as the result of a timeout when waiting for the other end to send an SPAP authenticate request.

### Change Passwords

The number of change password requests that sent or received on this interface.

### Alerts

The number of SPAP banners that have been sent or received.

### MCCP Call Reqs

Indicates that the sender requested another phone number to dial a second MP link.

### MCCP Callbacks

Indicates that the sender supplied a phone number on which to be called back to establish a second MP link.

### MCCP ACKs

The number of acknowledgments sent or received by MCCP.

### MCCP NAKs

The number of negative acknowledgments sent or received by MCCP.

### ccp

Lists statistics for compression control protocol.

### Example:

```
list ccp
CCP  Statistic      In      Out
-----
Packets:           24      25
Octets:            174     177
Reset Reqs         0        0
Reset Acks         0        0
Prot Rejects:     0        0
```

### Packets

Indicates the number of packets received and transmitted on this interface.



### Octets

Indicates the number of octets received and transmitted on this interface.

### Reset Reqs

The number of CCP dictionary “Reset Requests” that were transmitted or received.

### Reset Acks

The number of CCP dictionary “Reset Acknowledgments” that were transmitted or received.

Reset Request and Reset Acknowledgment packets are control packets passed between the CCP entities at each end, used to maintain synchronization of the data dictionaries at each end of the link.

### Prot Rejects

Indicates the number of protocol rejects of CCP packets sent by the peer (reception of a protocol reject would signify that the peer does not support CCP).

**cdp** Displays statistics associated with compressed data packets sent or received on this interface.

### Example:

```
list cdp
Compression Statistic      In                Out
-----
Packets:                   31035             46550
Octets:                    1614885           2421137
Compressed Octets:         931416            1521039
Incompressible Packets:    0                 0
Discarded Packets:         0                 0
Prot Rejects:              0                 -
Compression Ratios         1.70              1.70
```

### Packets

These counters indicate the number of compressed datagrams sent and received. On the output side, the count includes only those packets that were actually sent as PPP compressed datagrams; it does not include packets that were found to be incompressible and sent in their original uncompressed form.

These counters count the packets sent or received that had the PPP protocol type of X'00FD' (CDP). When STAC extended mode or MPPC has been negotiated, incompressible packets may be encapsulated in CDP datagrams. This encapsulation would include the incompressible packets in these counts.

### Octets

These counters indicate the number of bytes effectively transmitted or received in compressed form. These counts reflect the lengths of the original datagrams before compression or after decompression.

### Compressed octets

These counters indicate the number of bytes for all of the compressed datagrams sent and received. These counts are the lengths of the actual CDP packets after compression or before decompression.

### Incompressible packets

These counters indicate the number of packets that were incompressible and therefore sent in original uncompressed form.

## Monitoring PPP Interfaces (Talk 5)

### Discarded packets

These counters indicate how many packets were discarded because they could not be successfully decompressed. Typically these packets will be packets that the peer was transmitting just after the router has sent a Reset-Request, but before the peer has received and processed the Reset-Request. Packets are also dropped if the router detects that data in the packets is incorrect. An example of incorrect data is a packet that contains a bad sequence number.

If the number of discarded packets increases too rapidly, then packets are being lost or corrupted on the line, probably due to noise on the line, and the link performance may be degraded.

### Protocol rejects

This counter indicates the number of Protocol-Rejects of CDP packets that have been received from a peer. This count should be zero, because the link will not send CDP packets if the use of compression has not already been negotiated.

### Compression ratios

The ratios give an approximate indication of the effectiveness of the compressor and decompressor. These ratios are based on the number of plain-text bytes divided by the number of corresponding compressed bytes, so values greater than 1 are preferable for both input and output. The higher the number, the more effective the compression.

The output ratio is computed as the ratio of the number of original plain-text bytes divided by the number of bytes sent as a result of attempting compression - whether the packet actually was compressed or sent as a CDP packet. If a data stream does not compress well and most of the packets are sent in their original form or in enlarged CDP packets, the compression output ratio will drop. If the ratio drops below 1.0, the compressor is actually reducing the effective bandwidth of the line rather than increasing it, and should be disabled on that interface if the state persists for a long time.

The input ratio is computed based on the number of bytes received in CDP frames divided into the number of decompressed bytes. Unlike the output ratio, this count does not include any packets that were incompressible and sent in plain-text form. This is because the router cannot determine if a received non-CDP packet was an incompressible packet that the peer sent in plain-text form, or just a packet that the peer did not attempt to compress.

Because of the method of calculation, the output ratio on one end of the link does not necessarily match the input ratio at the other end.

### compression

This command displays the same information as `list cdp`.

**bcp** Lists statistics for the Bridging control protocol. These fields are the same as those described under the **list ip** command. (See "ip" on page 638.)

### Example:

```
list bcp
BCP Statistic          In          Out
-----
```

## Monitoring PPP Interfaces (Talk 5)

```
Packets:          0          0
Octets:           0          0
Prot Rejects:    -
```

**brg** Lists statistics on the bridge packets received and transmitted over the PPP interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list brg
BRG Statistic      In          Out
-----
Packets:           0          0
Octets:            0          0
Prot Rejects:     -
```

**stp** Lists statistics for the spanning tree protocol. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list stp
Spanning Tree Statistic  In          Out
-----
Packets:                 0          0
Octets:                  0          0
```

**nbcpc** Lists NetBIOS Control Protocol statistics for the point-to-point interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list nbcpc
NBCP Statistic      In          Out
-----
Packets:            0          0
Octets:             0          0
Prot Rejects:      -
```

**nbfcpc** Lists NetBIOS Frame Control Protocol statistics for the point-to-point interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list nbfcpc
NBFCP Statistic      In          Out
-----
Packets:            0          0
Octets:             0          0
Prot Rejects:      -
```

**ipcp** Lists Internet Protocol Control Protocol statistics for the point-to-point interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example: When RTP Header Compression is configured:

```
PPP 0>list ipcp
IPCP Statistic      In          Out
-----
Packets:            0          0
Octets:             0          0
Prot Rejects:      -

RFC 2508 TCP/UDP/RTP Packet Statistics

Packet Type          TX          RX
-----
Full Headers         0          0
Compressed TCP       0          0
Compressed TCP No Delta 0          0
Compressed Non TCP   0          0
Compressed UDP       0          0
```

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```
Compressed RTP          0          0
Context State           0          0

PPP 0>
```

### Example: When VJ Header Compression is configured:

```
PPP 0>li ipcp

IPCP Statistic          In          Out
-----
Packets:                0          0
Octets:                 0          0
Prot Rejects:           0          -
```

**ip** Lists all information related to IP packets over the point-to-point link.

### Example:

```
list ip
IP Statistic          In          Out
-----
Packets:             349         351
Octets:             128488    129412
Prot Rejects:        0          -
```

### Packets

Indicates the total number of IP packets transmitted (out) and received (in) over the current point-to-point interface.

### Octets

Indicates the total number of octets transmitted and received over the current IP connection.

### Prot Rejects

Indicates the total number of protocol reject packets transmitted and received over the current point-to-point interface.

## ipv6cp

Lists Internet Protocol version 6 Control Protocol statistics for the point-to-point interface. These fields are the same as those described under the **list ip** command. (See “ip”.)

### Example:

```
list ipv6cp
IPv6CP STATISTIC      IN          OUT
-----
PACKETS:              0          0
OCTETS:               0          0
PROT REJECTS:         0
```

**ipv6** Lists all information related to IPv6 packets over the point-to-point link. These fields are the same as those described under the **list ip** command. (See “ip”.)

### Example:

```
list ipv6
IPv6 Statistic          In          Out
-----
Packets:                0          0
Octets:                 0          0
Prot Rejects:           0
```

**ipxcp** Lists statistics for the IPX control protocol. These fields are the same as those described under the **list ip** command. (See “ip”.)

### Example:

```
list ipxcp
IPXCP Statistic          In          Out
-----
Packets:                0          0
Octets:                 0          0
Prot Rejects:           0          -
```

## Monitoring PPP Interfaces (Talk 5)

**ipx** Lists IPX statistics for the point-to-point interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

**Example:**

```
list ipx
IPX Statistic      In      Out
-----
Packets:           0        0
Octets:            0        0
Prot Rejects:     0        -
```

**atcp** Lists statistics for the AppleTalk control protocol. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

**Example:**

```
list atcp
ATCP Statistic     In      Out
-----
Packets:           0        0
Octets:            0        0
Prot Rejects:     0        -
```

**ap2** Lists AppleTalk Phase 2 statistics for the point-to-point interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

**Example:**

```
list ap2
AP2 Statistic      In      Out
-----
Packets:           349      351
Octets:            128488  129412
Prot Rejects:     0
```

**dncp** Lists statistics on the DECnet control protocol packets. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

**Example:**

```
list dncp
DNCN Statistic     In      Out
-----
Packets:           0        0
Octets:            0        0
Prot Rejects:     0        -
```

**dn** Lists statistics on the DECnet packets received and transmitted over the PPP interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

**Example:**

```
list dn
DN Statistic       In      Out
-----
Packets:           0        0
Octets:            0        0
Prot Rejects:     0        -
```

**osicp** Lists statistics for the OSI control protocol. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

**Example:**

```
list osicp
OSICP Statistic    In      Out
-----
Packets:           0        0
Octets:            0        0
Prot Rejects:     0        -
```

**osi** Lists statistics on the OSI packets received and transmitted over the PPP interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

## Monitoring PPP Interfaces (Talk 5)

### Example:

```
list osi
OSI Statistic      In      Out
-----
Packets:           0        0
Octets:            0        0
Prot Rejects:      0        -
```

**bvcp** Lists statistics on the Banyan VINES control protocol. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list bvcp
BVCP Statistic     In      Out
-----
Packets:           0        0
Octets:            0        0
Prot Rejects:      0        -
```

**vines** Lists statistics for the Banyan VINES packets received and transmitted over the PPP interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list vines
Vines Statistic    In      Out
-----
Packets:           10       13
Octets:            320     340
Prot Rejects:      0        -
```

**isrcp** Lists statistics for APPN ISR Control Protocol packets. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list isrcp
APPN ISRCP Statistic In      Out
-----
Packets:           3        3
Octets:            12       12
Prot Rejects:      0        -
```

**isr** Lists statistics on the APPN ISR packets received and transmitted over the PPP interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list isr
APPN ISR Statistic In      Out
-----
Packets:           220     219
Octets:            1266   1157
Prot Rejects:      0        -
```

**hprcp** Lists statistics for APPN HPR Control Protocol packets. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```
list hprcp
APPN HPRCP Statistic In      Out
-----
Packets:           3        3
Octets:            12       12
Prot Rejects:      0        -
```

**hpr** Lists statistics on the APPN HPR packets received and transmitted over the PPP interface. These fields are the same as those described under the **list ip** command. (See “ip” on page 638.)

### Example:

```

list hpr
APPN HPR Statistic      In          Out
-----
Packets:                780         715
Octets:                 131907     69685
Prot Rejects:          0           -

```

## LLC

Use the **LLC** command to access the LLC monitoring prompt. LLC commands are entered at this new prompt. See “LLC Monitoring Commands” on page 236 for an explanation of each of these commands.

**Note:** This command is available only when APPN is included in the software load.

### Syntax:

llc

---

## Point-to-Point Protocol Interfaces and the GWCON Interface Command

The PPP interface traffic is carried by an underlying data-link level device driver. Additional statistics that can be useful when monitoring PPP links may be obtained from the device driver statistics, which are displayed using the **interface** command from the GWCON environment. (For more information on the **interface** command, refer to “Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands” on page 109.)

The statistics in this section are displayed when you run the **interface** command from the GWCON environment (talk 5) for the following interfaces used in point-to-point configurations:

### Example:

+ interface 12

Net	Net'	Interface	Slot-Port	Self-Test Passed	Self-Test Failed	Maintenance Failed
12	12	PPP/0	Slot: 8 Port: 2	2	1	0

Point to Point MAC/data-link on V.35/V.36 interface

Adapter cable: V.35 DTE

V.24 circuit: 105 106 107 108 109  
 Nicknames: RTS CTS DSR DTR DCD  
 PUB 41450: CA CB CC CD CF  
 State: ON ON ON ON ON

Line speed: 64.000 Kbps  
 Last port reset: 1 hour, 20 minutes, 42 seconds ago

Input frame errors:			
CRC error	0	alignment (byte length)	0
missed frame	182	too long (> 2062 bytes)	0
aborted frame	0	DMA/FIFO overrun	0
Output frame counters:			
DMA/FIFO underrun errors	0	Output aborts sent	0

**Net** Interface number as assigned by software during initial configuration.

**Net'** Base interface number as assigned by software during initial configuration.

**Note:** For dial circuit interfaces, Net' is different from Net. For dial circuit interfaces, Net' indicates the base interface (ISDN or V.25 bis) that the dial circuit uses.

## Monitoring PPP Interfaces (Talk 5)

### **Interface No**

Type of interface and its instance number. The Point-to-Point interface type is PPP.

**Slot** The slot number of the interface over which PPP is running.

**Port** The port number of the interface that is running PPP.

### **Self-Test: Passed**

Total number of times the point-to-point interface passed its self-test.

### **Self-Test: Failed**

Total number of times the point-to-point interface failed its self-test.

### **Maintenance: Failed**

Total number of maintenance failures.

### **Adapter cable**

Type of adapter cable that has been configured; for example, V.35 DTE.

### **V.24 circuit**

Circuits being used on the V.24. Note: The symbol - - - in monitoring output indicates that the value or state is unknown.

### **Nicknames**

Control signals. Note: The symbol - - - in monitoring output indicates that the value or state is unknown.

### **PUB 41450**

Pin assignments. Note: The symbol - - - in monitoring output indicates that the value or state is unknown.

**State** State of the V.24 circuits (on or off). Note: The symbol - - - in monitoring output indicates that the value or state is unknown.

### **Line speed**

Configured line speed or default value assumed (if line speed is configured as 0).

### **Last port reset**

Length of time since the port was reset.

### **CRC error**

The number of packets received that contained checksum errors and as a result were discarded.

### **Alignment (byte length)**

The number of packets received that were not an even multiple of 8 bits in length and as a result were discarded.

### **Too long (> 2048 bytes)**

The number of packets that were greater than the configured frame size, and as a result were discarded.

### **Aborted frame**

The number of packets received that were aborted by the sender or a line error.

### **DMA/FIFO overrun**

The number of times the serial interface could not send data fast enough to the system packet buffer memory to receive them from the network.

### **Missed frame**

When a frame arrives at the device and there is no buffer available, the hardware drops the frame and increments the missed frame counter.



### L & F bits not set

On serial interfaces, the hardware sets input-descriptor information for arriving frames. If the buffer can accept the complete frame upon arrival, the hardware sets both the last and first bits of the frame, indicating that the buffer accepted the complete frame. If either of the bits is not set, the packet is dropped, the L & F bits not set counter is incremented, and the buffer is cleared for reuse.

**Note:** It is unlikely that the L & F bits not set counter will be affected by traffic.

### Output Frame Counters:

#### DMA/FIFO underrun errors

The number of times the serial interface could not retrieve data fast enough from the system packet buffer memory to transmit them onto the network.

#### Output aborts sent

The number of transmissions that were aborted as requested by upper-level software.

Statistics similar to the following are displayed for PPP dial circuits when you execute the **interface** command from the GWCON environment:

```
+interface 29
Net Net' Interface          Self-Test Passed Self-Test Failed Maintenance Failed
29 10  PPP/20                2           1           0
Point to Point MAC/data-link on V.25bis Dial Circuit interface
```

---

## Point-to-Point Protocol Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

Point-to-Point Protocol (PPP) supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

### GWCON (Talk 5) Activate Interface

PPP supports the GWCON (Talk 5) **activate interface** command with the following considerations:

- You cannot activate a PPP dial-circuit or PPP dial-in circuit unless the dial-circuit's (dial-in circuit's) base net is already active.
- You cannot activate a PPP dial-circuit if its base net is set for channelized ISDN.
- You cannot activate a Multilink-PPP (MP) net.
- You cannot activate a PPP net which is MP enabled.
- You cannot activate a PPP net when the global buffer size is less than 1500.

All PPP configuration changes are automatically activated except the following:

Commands whose changes are not activated by the GWCON (Talk 5) activate interface command
---

CONFIG, net, enable ccp
-------------------------

<b>Note:</b> Compression will not be enabled if this is the first PPP net with CCP enabled.
---

## Monitoring PPP Interfaces (Talk 5)

CONFIG, net, set lcp options (mru option)

**Note:** The MRU value will not be set higher than the buffer size allocated for the router at reboot.

## GWCON (Talk 5) Reset Interface

PPP supports the GWCON (Talk 5) **reset interface** command with the following considerations:

- You cannot reset a Multilink-PPP (MP) net.
- You cannot reset PPP links whose original configuration or desired configuration is a dedicated MP link.
- You cannot reset a PPP dial-circuit if any of the dial-circuit parameters that are configured at the dial-circuit config> prompt have changed.
- You cannot reset a PPP interface which is being used for WAN Restoral or WAN Reroute.

All PPP configuration changes are automatically activated except the following:

### Commands whose changes are not activated by the GWCON (Talk 5) reset interface command

CONFIG, net, enable ccp

**Note:** Compression will not be enabled if this is the first PPP net with CCP enabled.

CONFIG, net, set lcp options (mru option)

**Note:** The MRU value will not be set higher than the buffer size allocated for the PPP interface at reboot.

---

## Chapter 45. Using the Multilink PPP Protocol

This chapter describes how to use the Multilink PPP Protocol (MP). It includes the following sections:

- “MP Considerations” on page 646
- “Multichassis MP” on page 646
- “Configuring a Multilink PPP Interface” on page 647

The Multilink PPP Protocol allows you to increase the bandwidth of:

- PPP leased lines, including channelized and I43x ISDN circuits
- PPP ISDN dial circuits
- PPP V.25 bis dial circuits
- PPP Layer 2 Tunneling circuits

Increased bandwidth is accomplished by defining a **virtual link** made up of multiple links. The bandwidth of the resulting MP bundle is almost equal to the sum of the bandwidths of the individual links. The advantage is that large data packets transmitted across a single link can now be fragmented, transmitted across multiple links, and rebuilt at the receiving end station. MP uses both the Bandwidth Allocation Protocol and the Bandwidth Allocation Control Protocol to dynamically add and drop PPP dial circuits to a virtual link. MP also uses Bandwidth-On-Demand (BOD) to add “dedicated” MP dial links to an existing bundle.

There are two types of MP links: those that are dedicated and those that are simply enabled. A dedicated MP link is an MP-enabled interface configured as a link to a particular MP interface. If the link attempts to join another MP bundle, or if MP is not negotiated at all, the software terminates the link. All PPP links except for Layer-2-tunneling interfaces can be configured as dedicated MP links. PPP leased links must be configured as dedicated MP links.

PPP dial-circuits and Layer 2-Tunneling can be configured as MP enabled. An MP-enabled link that is not dedicated can become a link in any MP bundle. If MP is not negotiated, the link operates as an independent interface using the link’s configured protocols.

You can configure a Multilink PPP interface that consists of multiple PPP dial circuits as part of the MP bundle.

There are also two types of MP interfaces: those that have a dedicated link and those that do not. An MP interface needs a dedicated link in any one of the following situations:

- The link is only for the MP interface
- The MP interface is configured for outbound calls. The dedicated link must then be configured with the destination phone number and caller identification.
- The MP interface is configured to receive a particular inbound call. In this case, the dedicated link is configured with the inbound destination phone number and caller identification.
- The MP interface needs to perform outbound authentication. In this case, all links use the same authentication name.

MP interfaces that do not have a dedicated link must be inbound-only interfaces. These interfaces are similar to the any inbound dial circuit.

The Bandwidth Allocation Protocol (BAP) and its control protocol (BACP) allow an MP interface to increase and decrease its bandwidth by adding and dropping dial

## Using MP

circuits. When the bandwidth utilization algorithm determines that a link should be added to the bundle, if there is an available PPP dial-circuit, and the peer agrees, an additional call is placed.

BAP first searches for any idle dedicated PPP dial circuits for the MP interface, and then for any MP-enabled PPP dial circuit. It will not, however, use a dedicated PPP dial circuit of another MP circuit. The configured maximum number of links on the MP interface will never be exceeded.

BOD uses configured dial-circuit phone numbers to place calls when needed to add dedicated MP dial links to an existing bundle. Links are added to the bundle one at a time, if needed, during a polling period. BOD adds any PPP serial links to the bundle first and will retain the serial links throughout the life of the bundle. BOD only drops dial links.

MP supports the following features:

- BRS
- WRR
- WRS
- Dial-on-Demand
- DIALs

However, WRS, Dial-on-Demand, and DIALs are only supported on MP bundles that contain only dial circuits.

---

## MP Considerations

When configuring an MP bundle, keep the following in mind:

- Mixing dial circuits with “leased” lines causes the software to disable BAP on the bundle and use BOD instead. Only mix dial circuits with “leased” circuits when you desire to use BOD to manage the bundle.
- You cannot use Dial-on-Demand or WRS for MP bundles that contain either PPP “leased” lines or Layer 2 Tunneling circuits.
- You cannot use DIALs on bundles that contain PPP “leased” lines.
- All devices joining an MP bundle must have link speed configured.

**Important:**

1. Do not configure a bundle with media with extremely dissimilar properties. For example, configuring a bundle that contains a HSSI link and a V.25 bis link is not effective use of a bundle. The largest link should have no more than 4 times the capacity of the smallest link. If the speeds of the links in an MP bundle differ greatly, you may need to add receive buffers to the faster link.
2. When bundling ISDN B-channels with slower media types, you may need to increase the number of ISDN buffers. Bundling ISDN B-channels with slower links is not recommended for ISDN primary.

---

## Multichassis MP

An MP bundle with a Layer 2 Tunnel that contains a phone hunt group that spans multiple physical Network Access Servers is known as a *multichassis MP*. Multichassis MP uses rhelm or user-based tunneling (see “Using Local or Remote Authentication” in *Using and Configuring Features*) to establish the MP endpoint destination. See “Using Layer 2 Tunneling Protocol (L2TP)” in *Using and Configuring Features* for more information about L2TP.

## Configuring a Multilink PPP Interface

Configuring an MP interface depends on the type of interface used in the MP bundle. The following sections contain examples of the various configurations.

After configuring the MP interface, you may configure bandwidth-on-demand (BOD). The following example configures BOD on existing MP interface 17:

```
Config> net 17
MP config: 17> enable bod
Enable BAP? [N]

MP config: 17> set bandwidth-on-demand parameters
Add bandwidth % [90]:
Drop bandwidth % [70]:
Bandwidth test interval (sec) [15]

MP config: 17>
```

## Configuring MP on PPP Dial Circuits

This section shows how to configure a Multilink PPP interface by using an example that configures Multilink PPP with two ISDN dial circuits.

1. Add the two dial circuits and the multilink PPP interface.

```
*t 6

Config>add dev dial-circuit
Adding device as interface 7
Defaulting Data-link protocol to PPP
Use "net 7" command to configure circuit parameters
Config>add dev dial-circuit
Adding device as interface 8
Defaulting Data-link protocol to PPP
Use "net 8" command to configure circuit parameters
Config>add dev multilink-ppp
Enter the number of multilink PPP interfaces [1]?
Adding device as interface 9
Defaulting Data-link protocol to PPP
Use "net intf" command to configure circuit parameters
Config>
```

2. Configure each PPP dial circuit. (See “Chapter 54. Configuring and Monitoring Dial Circuits” on page 745.) In this example, the destination, call direction, and LIDs are set for one of the dial circuits.

```
Config>net 7
Circuit configuration
Circuit config: 7>set dest out
Circuit config: 7>set calls outbound
Circuit config: 7>set net 6
Circuit config: 7>
```

3. Enable MP on each dial circuit to be used for MP as follows:

```
Circuit config: 7>encapsulator
Point-to-Point user configuration
PPP 7 Config>enable mp

Enabled as a Multilink PPP Link,
Use as a dedicated Multilink PPP link? [No]: yes
Multilink PPP net for this Multilink PPP link [1]? 9
NOTE: PPP configuration will be obtained from the Multilink PPP
net. It is NOT necessary to configure PPP for this net!
```

**Note:** You cannot configure PPP parameters for dedicated links from this prompt. Dedicated links use the existing MP interface’s PPP configuration.

By answering “Yes” to the question “Use as a dedicated Multilink PPP link?” the link becomes dedicated to the specified Multilink PPP interface (9 in this

## Using MP

example). In this case, the link **must** be used for an MP bundle and **must** join the specified MP interface. The link cannot be used as a regular PPP dial circuit.

Answering “No” to “Use as a dedicated Multilink PPP link?” will allow this PPP dial-circuit to join any MP interface. At least one PPP dial-circuit **must** be a dedicated link to an outbound MP interface.

A dedicated PPP dial circuit obtains all PPP parameters (LCP options, authentication, and others) from its MP interface. MP enabled PPP dial circuits joining the same MP bundle **must** negotiate the same LCP parameters and authentication name.

4. Configure the MP interface. Protocols, BAP, BRS, WAN restoral, WAN reroute, and dial-on-demand are all run on the MP interface and not the PPP dial circuits.

## Configuring MP on PPP Serial Links

To configure MP on a PPP serial link, you enable MP on the interface using the **net** command. The link obtains its PPP configuration from the MP net.

### Example:

```
Config> net 1
PPP 1 Config> enable MP
```

```
Multilink PPP net for this Multilink PPP link [1]? 8
NOTE: PPP configuration will be obtained from the Multilink PPP
      net. It is NOT necessary to configure PPP for this net!
PPP 1 Config>
```

## Configuring MP on Layer-2-Tunneling Nets

To configure MP on an L2TP net, you enable MP through the L2TP encapsulator. You then must configure the same PPP negotiation parameters (see “Configuring L2TP” in *Using and Configuring Features*) for information about all nets joining in a single bundle.

### Example:

```
Config> feature layer-2-tunneling
Layer-2-Tunneling Config> encapsulator
PPP-L2TP Config> enable mp
```

```
NOTE: It IS necessary to configure PPP for this net! PPP
      negotiation parameters must be configured the same for
      all nets wishing to join the same Multilink PPP bundle.
PPP-L2TP Config>
```

## Configuring Multichassis MP

To configure MP for Multichassis MP, configure the DIALs feature for multichassis MP. The software prompts you for the endpoint discriminator to use.

### Example:

```
Config> feature DIALs
DIALs Config> set multi-chassis-mp
      Enter Endpoint Discriminator to use from stacked group (0 for box S/N): 2345
DIALs Config>
```

The following example shows multichassis MP when ports RTR-2 and RTR-3 are in a hunt group.

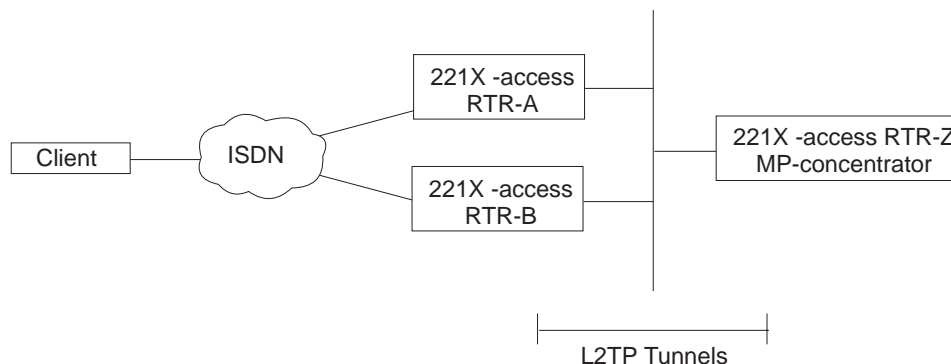


Figure 48. Multichassis MP

Because there is a many-to-many relationship between access routers and MP-concentrators, all access routers (RTR-A, RTR-B) should be kept on a separate administrative domain from MP concentrator routers (RTR-Z). This applies if you want to use remote authentication (that is, RADIUS), you will need two RADIUS servers, one for access routers and one for MP concentrators. If you are using local-list, you are already using separate administrative domains.

In this scenario, you can choose to tunnel based on PPP username or “rhelm” name. It is less rigorous to use rhelm-based tunneling. The idea is to configure a tunnel-profile for RTR-Z on both RTR-A and RTR-B. No additional PPP users are required on these routers. RTR-Z would require 2 tunnel-profiles: one for RTR-A and one for RTR-B and a PPP username (in the form <username>@RTRZ) for each anticipated user. All dial-in circuits are configured on the “access” routers. The “MP concentrators” would have Layer-2-tunneling devices and multilink-PPP devices.

You have now statically configured a multichassis MP. This means that a particular PPP username will always terminate MP on a preconfigured router, as opposed to supporting an additional protocol that dynamically finds MP bundle heads and tunnels as needed. This network implementation will also help avoid client PPP negotiation idiosyncrasies when using different media types for each link in a bundle (for example, tunnel one link and not the other). For example, DIALs clients cannot renegotiate LCP at any point. Also, Microsoft DUN clients do not fully support LCP renegotiation.

## Packet Interleaving on Multilink PPP

Packet Interleaving on Multilink PPP provides support for integrated service that allows multiple classes of data to be interleaved during transmission. This will minimize end-to-end delays for real-time multimedia flows.

Packet Interleaving can be enable or disabled. For configuration information see “MP Configuration Commands for Multilink PPP Interfaces” on page 651.





---

## Chapter 46. Configuring and Monitoring Multilink PPP Protocol (MP)

This chapter describes how to configure specific Multilink PPP interfaces in a device. It includes:

- “Accessing the MP Configuration Prompt”
- “MP Configuration Commands for Multilink PPP Interfaces”
- “Monitoring MP Interface Status” on page 655
- “Accessing the MP Monitoring Commands” on page 655
- “Multilink PPP Protocol Monitoring Commands” on page 655

---

### Accessing the MP Configuration Prompt

To access the MP config> prompt:

1. Enter **talk 6** at the \* prompt.
2. Enter **net n**, where n is the number of the dial circuit or MP interface that you enabled to use MP.

**Note:** You are now configuring the Multilink PPP interface and not the PPP dial circuit that is part of the MP bundle.

---

### MP Configuration Commands for Multilink PPP Interfaces

Table 83 lists the commands available at the MP config> prompt.

Table 83. MP Configuration Commands

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Disable	Disables interleaving and the negotiation of bandwidth on demand.
Enable	Enables interleaving and the negotiation of bandwidth on demand.
Encapsulator	Places you in the PPP config> prompt so you can change the data-link protocol configuration.
List	Displays the MP interface configuration parameters.
Set	Configures MP interface for inbound or outbound traffic. Also allows you to set the idle timeout and other MP and BAP parameters.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

#### Disable

Use the **disable** command to disable the negotiation of bandwidth-on-demand (BOD) and to disable interleaving. Disabling BOD prevents the link from allocating additional bandwidth when necessary. Disabling interleaving disables the integrated service that allows multiple classes of data to be interleaved during transmission.

**Syntax:**

**disable** bod  
interleaving

## Configuring MP

### Enable

Use the **enable** command to enable the negotiation of BOD and to enable interleaving. Enabling BOD allows the link to allocate additional bandwidth when necessary. Enabling interleaving allows multiple classes of data to be interleaved during transmission.

#### Syntax:

**enable**

**bod**

**interleaving**

```
MP config: 0>enable interleaving
Interleaving Enabled. New MaxFrag = 200, new MinFrag = 128
```

```
NOTE: Interleavable traffic will not be compressed and/or encrypted
even if these functions are enabled for this interface!!!!
```

### Encapsulator

Use the **encapsulator** command to access the PPP link-layer configuration for the Multilink PPP interface.

#### Syntax:

**encapsulator**

#### Example:

```
encapsulator
Point-to-Point user configuration
PPP config>
```

### List

Use the **list** command to display the current MP configuration.

#### Syntax:

**list**

#### Example:

```
list
Idle timer = 0 (fixed circuit)
Outbound calls = allowed
Dialout MP Link net = 7
Max fragment size = 750
Min fragment size = 375
Maximum number of active links = 2
Links associated with this MP bundle:
net number 7
net number 8
Interleaving =Disabled

BAP enabled
Add bandwidth percentage = 90
Drop bandwidth percentage = 70
Bandwidth test interval (sec) = 15
```

#### Idle timer

The setting of the idle timer for this circuit in seconds.

A setting of 0 indicates a fixed circuit. A nonzero setting configures a dial-on-demand MP circuit that will be brought down when the circuit is idle for the specified number of seconds. The circuit is reactivated when network traffic resumes.

### Outbound calls

Specifies whether the interface is configured to initiate outbound calls. If the interface cannot initiate outbound calls, this line is not displayed.

### Inbound calls

Specifies whether the interface is configured to initiate inbound calls. If the interface cannot accept inbound calls, this line is not displayed.

### Max fragment size

Specifies the largest number of bytes of data a packet can contain before the packet is fragmented to be sent over MP links.

### Min fragment size

This is the minimum size of the fragments (in bytes) the software creates when a packet exceeds *Max fragment size*.

### Maximum number of active links

Specifies the configured maximum number of links in the MP virtual link (also known as *bundle*).

### Links associated with this MP bundle

Displays the links dedicated to this MP interface.

### Interleaving

Specifies whether or not packet interleaving is being used. This feature requires additional Classification Layer (i.e., BRS, DiffServ) configuration

### BAP enabled

Specifies whether BAP is enabled on this interface.

### Add bandwidth percentage

The amount of bandwidth utilization at which the software will try to add a new link if BAP is enabled.

### Drop bandwidth percentage

The amount of bandwidth utilization at which the software will remove a link from the MP bundle if BAP is enabled.

### Bandwidth test interval

The time, in seconds, after which the software will check the bandwidth utilization to determine whether to add or drop a link from the bundle.

## Set

Use the **set** command to configure:

- The MP interface for inbound or outbound calls
- The idle timeout
- The MP parameters
- The BAP parameters

### Syntax:

```
set                bod parameters
                   calls
                   idle
                   mp parameters
```

### bod parameters

Prompts you to specify the BOD add and drop bandwidth percentages and the BOD test interval.

## Configuring MP

### Example:

```
set bod parameters
Add bandwidth % [90]? 80
Drop bandwidth % [70]? 50
Bandwidth test interval (sec) [15]? 25
```

### Add bandwidth %

The amount of bandwidth utilization at which the software will try to add a new link.

**Valid Values:** 1 to 99

**Default Value:** 90

### Drop bandwidth %

The amount of bandwidth utilization at which the software will remove a link from the MP bundle.

**Valid values:** 1 to 99

**Default value:** 70

### Bandwidth test interval (sec)

The time, in seconds, after which the software will check the bandwidth utilization to determine whether to add or drop a link from the bundle.

**Valid Values:** 10 to 200 seconds

**Default Value:** 15

**calls** Specifies whether this MP interface will initiate outbound calls, only accept outbound calls, or participate in both types of calls.

**Valid values:** inbound, outbound, or both

**Default value:** inbound

**Note:** If you specify outbound or both, the software will request the net number of the dedicated MP link that will place the first call.

### Example:

```
set calls outbound
Dialout MP link net for this MP net []? 4
```

**idle** Specifies the time period in seconds that an interface can have no protocol traffic at which the MP interface will end calls on all the links.

**Valid Values:** 0 to 65535

**Default Value:** 0

### mp parameters

Prompts you to enter the maximum and minimum fragment sizes and the maximum number of active links.

### Example:

```
set mp parameters
Max frag size [750]? 675
Min frag size [375]? 300
Max number of active links [2]? 4
```

### Max frag size

Specifies the largest of number of bytes of data a packet can contain before the packet is fragmented to be sent over MP links.

**Valid Values:** 100 to 3 000

**Default Value:** 750

#### Min frag size

This is the minimum size of the fragments (in bytes) the software creates when a packet exceeds **Max fragment size**.

**Valid Values:** 100 to 3 000

**Default Value:** 375

#### Max number of active links

Specifies the configured maximum number of links in the MP virtual link (also known as **bundle**).

**Valid Values:** 1 to 64

**Default Value:** 2

---

## Monitoring MP Interface Status

To determine the status of all the MP interfaces in your device, use the **configuration** command in **talk 5** (see “Configuration” on page 112).

---

## Accessing the MP Monitoring Commands

To access the MP monitoring commands:

1. Enter **talk 5** at the \* prompt.
2. Enter **net n**, where **n** is the number of the MP interface that was created in talk 6 using **add device multilink-ppp** command.

---

## Multilink PPP Protocol Monitoring Commands

Table 84 shows the monitoring commands available for an MP interface.

*Table 84. MP Monitoring Commands*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Displays BAP, BACP, BOD, and MP statistics, errors, and other information.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## List

Use the **list** command to display information about the MP interface including bandwidth allocation statistics.

#### Syntax:

```
list
    bacp
    bap
    control bacp
    control bod
    control mp
    mp
```

## Monitoring MP

**Note:** The examples that follow assume that the MP interface on this device is net number 6.

**bacp** The **list bacp** command lists the statistics for bandwidth allocation control packets which have been sent or received on this MP circuit.

**Example:**

```
PPP 6> list bacp
```

BACP Statistic	In	Out
-----	--	---
Packets:	6	8
Octets:	60	80
Rejects:	0	-

**bap** The **list bap** command lists the statistics for bandwidth allocation protocol packets which have been sent or received on this MP circuit.

**Example:**

```
PPP 6> list bap
```

BAP Statistic	In	Out
-----	--	---
Packets:	3	3
Octets:	22	37
Call Requests:	1	0
Call Response(ACK):	0	1
Call Resp(NK & FLLNK):	0	0
Call Response(Rej):	0	0
Callback Requests:	0	0
Callback Response(ACK):	0	0
Callback Resp(NK & FLLNK):	0	0
Callback Response(Rej):	0	0
Drop Requests:	0	1
Drop Response(ACK):	1	0
Drop Resp(NK & FLLNK):	0	0
Drop Response(Rej):	0	0
Call Status(Success):	1	0
Call Status(Fail):	0	0

There are four different responses to a peer's request: ACK, NAK, FULL-NAK, and REJECT.

**ACK** Indicates the peer's request has been granted.

**NAK (NK)**

Indicates that the peer's request is supported but not desired at this time. Try again later.

**FULL-NAK (FLLNK)**

Indicates that the peer's request is supported but because of a resource condition, cannot be granted at this time. The request should not be sent again until the total bandwidth across the MP bundle changes.

**REJECT (REJ)**

Indicates that the request is not supported.

**control bacp**

The **list control bacp** command lists the current state of the BACP state-machine within PPP. The state information is identical to that produced for all of the PPP control protocols. Information about favored peer is also listed. Favored peer is used to alleviate BAP packet collisions (when both sides simultaneously initiate requests). During BACP negotiations, each side sends a magic-number and the one with the smallest magic number is the favored peer and should take precedence in the event of a collision. Typically, the call initiator will choose a **magic number** of X'1' and the call receiver will choose a magic number of X'FFFFFFF' establishing the call initiator as the favored peer.

```

PPP 6> list control bacp
BACP State:                Open
BACP Option                 Local          Remote
-----
Magic Number:              FFFFFFFF          1
Favorite Peer:             NO                YES

```

### control bod

The **list control bod** command lists the current state of bandwidth-on-demand (BOD). This information includes BAP state, configured bandwidth-on-demand parameters for adding and subtracting bandwidth, current bandwidth, and information from the last bandwidth poll.

Valid BAP states are:

#### Closed

BACP is not opened – BAP is either not enabled or not supported by the peer.

**Ready** BACP is opened and there is no outstanding request being processed.

#### Call Req Sent

There is an outstanding call-request that was sent from the local machine.

#### Callback Req Sent

There is an outstanding callback-request that was sent locally.

#### Call Placed

As a result of a BAP request to add bandwidth, a call has been placed.

#### Retry Status Sent

The outgoing call failed to join the MP bundle, a retry status was sent.

#### No Retry Status Sent

The outgoing call either succeeded or exhausted all retries, a no retry status was sent.

#### Drop Req Sent

There is an outstanding drop request that was sent locally.

Configured bandwidth-on-demand parameters include add percentage, drop percentage, maximum number of active links in the MP bundle, and the bandwidth polling interval.

A BAP request to add a link to the bundle will be initiated if both the following conditions are met:

- The current number of active links is less than the configured maximum number of links.
- The bandwidth utilization across all links in the MP bundle is greater than the add percentage of the total available bandwidth for the MP bundle.

A BAP request to drop a link from the MP will be initiated if both the following conditions are met:

- The number of active links is greater than one.
- The bandwidth utilization across all links in the MP bundle is less than the drop percentage of the total available bandwidth for the MP bundle for the number of links minus one.

## Monitoring MP

Bandwidth can be polled only when BAP is in the ready state. The information listed from the previous poll will give you an idea of the bandwidth utilization across the MP bundle.

These two sets of information are displayed when a drop can be initiated:

- Bandwidth utilization across the entire bundle
- Bandwidth utilization across number of links minus one

To prevent thrashing, the second set of information is used when determining whether to drop a link.

### Example:

```
PPP 11>list control bod
```

```
BOD :                               Disabled
BAP :                               Disabled
Bandwidth test interval (sec):      15
Add bandwidth percentage:           90
Drop percentage (links-1):          70
Max # active links in MP bundle:     2
Time since last Bandwidth check (sec): 19
Currently:
  # active links in MP bundle:       0
  Total MP bandwidth (Bytes/sec):    0
Last Bandwidth Check:
  # active links in MP bundle:       0
  Avg Inbound bandwidth util (%):    0
  Avg Outbound bandwidth util (%):  0
```

### control mp

The **list control mp** command lists the current state of this MP circuit including the number of active links and bandwidth, the configured maximum number of links, and statistics for number of dropped packets. Dropped MP packets are classified into four categories:

**M** The packet is dropped because a sequence number has not been received and it is less than the minimum sequence number across all links' last received sequence number.

#### Timeout

The packet is dropped because a sequence number has not been received during a timeout period.

#### Q depth

The packet is dropped because the maximum queue depth was exceeded.

#### Seq order

The packet is dropped because the sequence number received was not expected. This occurs when MP receives delayed packet that it has already declared lost.

If a packet is dropped at the network layer, it can be either an M, Timeout, or Q depth packet. These counters are incremented appropriately when a packet is dropped.

### Interleaving

Specifies whether or not packet interleaving is being used.

```
PPP 1> list control mp
Current # active links in MP bundle: 2
Max # active links in MP bundle:    2
Total MP bandwidth (Bytes/sec):     512000
Dropped Frags (lost packets):       0
Dropped Frags (timeout or receive overflow): 0
Dropped Frags (sequence not expected): 0
Interleaving:                       Disabled
```



```
PPP 1>
```

**mp**

The **list mp** command lists the statistics for packets which have been sent or received on this MP circuit. This packet count represents the number of packets that have been classified as interleavable data and transmitted out the MP interface. The number of bytes displayed is for pre-decompressed packets if compression was negotiated for the multilink PPP bundle.

```
PPP 6> list mp
```

MP Statistic	In	Out
Bytes (Compressed):	61230	60259
Interleaved packet count: NA 0 has been added.		

## Monitoring MP

---

## Chapter 47. Configuring and Monitoring SDLC Relay

This chapter includes an overview of the Synchronous Data Link Control (SDLC) Relay function and describes its configuration and operational commands.

For further information on when to use DLSw SDLC versus SDLC Relay, refer to “Relationship to the SDLC Relay Function” in the “Using DLSw” chapter of *Protocol Configuration and Monitoring Reference Volume 1*.

The chapter includes the following sections:

- “Overview of SDLC Relay”
- “Basic Configuration Procedure” on page 663
- “Dynamic Reconfiguration” on page 663
- “Accessing the SDLC Relay Monitoring Environment” on page 671
- “SDLC Relay Monitoring Commands” on page 671
- “SDLC Relay Interfaces and the GWCON Interface Command” on page 674
- “SDLC Relay Dynamic Reconfiguration Support” on page 674

---

### Overview of SDLC Relay

SDLC Relay is a function that transports SDLC packets encapsulated in IP over an IP connection. SDLC connections consist of a primary (polling) end point and a secondary (polled) end point. They are either point-to-point (one primary and one secondary device) or multipoint (one primary and several secondary devices). SDLC Relay maintains this design, except that routers forward the frames between the primary and secondary SDLC devices.

Figure 49 on page 662 shows an example of an SDLC Relay configuration with the primary SDLC device connected to two secondary SDLC control units.

## Configuring and Monitoring SDLC Relay

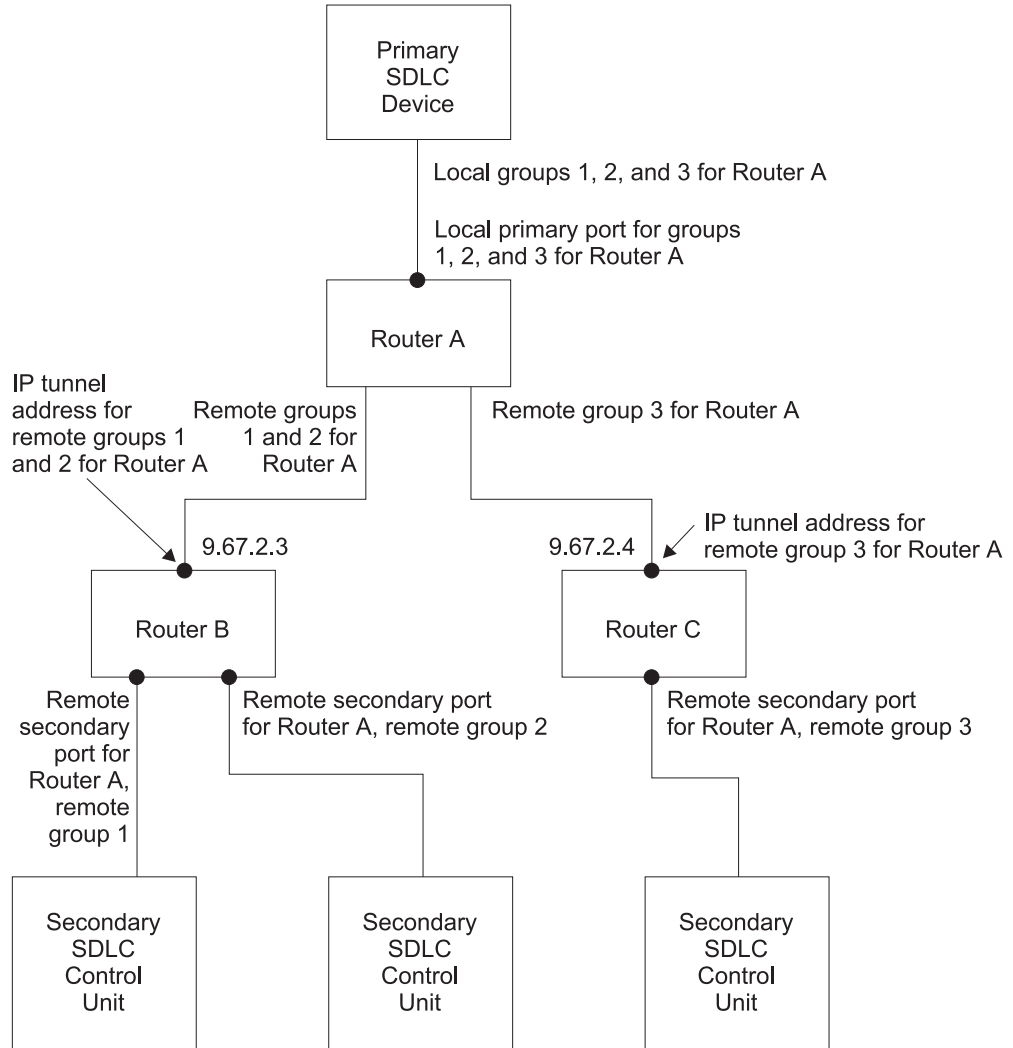


Figure 49. Example of an SDLC Relay Configuration

As shown, the primary and secondary SDLC devices are each locally attached to a router. The routers communicate over an IP connection or tunnel and serve as a pipe between the SDLC end points. During configuration, you define the connections to the routers as virtual groups. You also assign arbitrary numbers to these groups to identify them for the router. A local group includes a local port, which is a router's local interface. Each local group has one corresponding remote group that consists of a remote port, which is the interface of the remote router, and the address of an IP tunnel that connects the local router to the remote router. The remote router is the local router's peer. For example, Router B and Router C are remote routers for Router A. The IP address of the tunnel must be the internal IP address of the remote router. Refer to the **set internal-IP-address** command in the *Protocol Configuration and Monitoring Reference Volume 2* for more information.

Each port is also identified as primary or secondary, depending upon the final end point of the connection. Within each group, one port is primary and one is secondary. Although the groups in the example have the same number for the local group and the corresponding remote group, this matching is not required. For example, for Router A, local group 2 includes the local primary port for local group 2. The corresponding remote group is also numbered 2, but it could have been identified by another number.

## Configuring and Monitoring SDLC Relay

The secondary SDLC control units connected to Router B in this example are not connected to the same line. This is an example of a virtual multipoint connection. If the SDLC control units are directly connected to the same line, that is considered a physical connection. Within one network, you can have both physical and virtual connections.

In a multipoint network, the secondary devices are identified by one-byte or two-byte station addresses. All SDLC relay routers within one SDLC network must use the same number of address bytes, either all one-byte or all two-byte. The routers identify the secondary SDLC control units dynamically. Based upon that knowledge, the routers can transmit frames for a particular device to that device. Broadcast frames continue to be broadcast from the sending device to all other devices in the network.

Only the half-duplex transmission mode is supported. This means that request-to-send (RTS) must be raised before each transmission. Clear-to-send (CTS) does not remain up permanently.

---

### Basic Configuration Procedure

This section outlines the minimum configuration steps required to get the SDLC Relay protocol up and running. For more explanation of the parameters, see “Overview of SDLC Relay” on page 661 and the descriptions of the configuration commands.

- *Add a local group.* You must configure the local group using the **add group** command.
- *Add a local port.* This identifies the interface that you are using for the local port. This also assures that no IP address is configured for the interface that you select. Use the **add local-port** command.
- *Add a remote port.* This identifies the port directly connected to the remote side of the serial line. Use the **add remote-port** command.

---

### Dynamic Reconfiguration

You can use the Talk 5 **reset interface#** and **activate interface#** commands to activate all SDLC Relay parameters that you have configured on an interface using Talk 6. Alternatively, you can restart or reload the router to make your new configuration changes take effect.

---

### Accessing the SDLC Relay Configuration Environment

To access the SDLC relay (SRLY) configuration environment:

1. At the `Config>` prompt, enter **set data-link srlly**.
2. Enter the interface number.
3. To configure the SRLY interface, enter the **network interface#** command. The `SRLY interface# Config>` prompt is displayed when **network interface#** is entered:

```
Config>network 2  
SDLC Relay interface user configuration  
SRLY 1 Config>
```

4. To configure the SRLY protocol parameters, enter the **protocol sdlc** command. The SDLC Relay `config>` prompt is displayed when **protocol sdlc** is entered:

```
Config>protocol sdlc  
SDLC Relay protocol user configuration  
SDLC Relay config>
```

### SDLC Relay Configuration Commands

This section summarizes the SDLC Relay configuration commands. Both the **network** and **protocol** parameters for SDLC Relay are documented in this chapter.

The SDLC Relay configuration commands allow you to specify router parameters for interfaces transmitting SDLC Relay frames. Table 85 shows the commands for both the **network sdlc** and **protocol sdlc**.

Table 85. SDLC Relay Configuration Commands Summary

Command	Network SRLY	Protocol SDLC	Function
? (Help)	yes	yes	Lists all of the SDLC Relay configuration commands or lists the options associated with specific commands.
Add		yes	Adds groups, local ports, and remote ports.
Delete		yes	Deletes groups and ports.
Disable		yes	Disables groups and ports.
Enable		yes	Enables groups and ports.
List	yes	yes	Displays entire SDLC Relay and group specific configurations.
Set	yes		Sets the link parameters and remote station parameters.
Exit	yes	yes	Exits the SDLC Relay configuration environment and returns to the CONFIG environment.

## Add

Use the **add** command to add local groups, local ports, and remote ports.

### Syntax:

```
add                group local-group# group-type local-group-name
                   _local-port
                   _remote-port
```

**group** Defines a local group. A local group is identified by a number and a name.

#### Example: add group

```
Local group number: [1]?
Local group name [ ]? CHICAGO-TO-MIAMI
(P)oint-to-Point or (M)ultipoint: [P]?
```

#### Local-group-number

The group number that you are designating to identify the local group.

#### Local-group-name

This is the name of this local group. You can use up to 32 ASCII characters to name the local group. If you do not provide a name, the default name of LOCAL-GROUP-*n* is used, where *n* is the local group number.

#### Group-type

The group types are point-to-point or multipoint.

#### local-port

Identifies the interface that you are using for the local port.

#### Example: add local-port

## Configuring and Monitoring SDLC Relay

```
Local group number: [1]?  
Interface number: [0]? 3  
(P)rimary or (S)econdary: [S]? p
```

### Local group number

The local group number for the port.

### Network or interface number

The network or interface number of the router that designates the local port.

### Primary or Secondary

Designates the port type, primary (P) or secondary (S). The default is secondary.

### remote-port

Identifies the port directly connected to the serial line on the remote router.

### Example: add remote-port

```
Local group number: [1]?  
IP address of remote router: [0.0.0.0]? 9.67.2.3  
Is the remote's upper group number limit 255 (current) or 15 (migration): [255]?  
Remote router group number: [1]?  
Does the connection use 2-byte station addressing: [Y]?  
(P)rimary or (S)econdary: [S]? s
```

### Group number

The local group number for the port.

### IP address of remote router

The internal IP address of the remote router. It identifies the IP tunnel that connects the router to the remote router.

### Upper group number limit

Support level of the remote router, defined by the upper limit of group numbers that you can use. The default is current, which is a limit of 255 and a range of 1 to 255.

### Remote router group number

The group number of the remote group to which this remote port belongs. The local and remote group number are not required to be the same number.

### Two-byte or one-byte station addressing

The number of bytes in the station address. The station address is the SDLC address of the secondary SDLC device. The default is two bytes.

### Primary or Secondary

Designates the port type, primary (P) or secondary (S). The default is secondary.

## Delete

Use the **delete** command to remove group numbers, local ports, and remote ports.

### Syntax:

```
delete                group . . .  
                        _local-port . . .  
                        _remote-port
```

### group group#

Removes a local group (group#).

## Configuring and Monitoring SDLC Relay

### **local-port** *group#*

Removes the local port for the specified group.

### **remote-port**

Removes the remote port for the specified group.

#### **Example: delete remote-port**

Group number: [1]? 1

#### **Group number**

The remote group number for the remote port.

## Disable

Use the **disable** command to suppress relaying for an entire relay group or a specific relay port.

### **Syntax:**

```
disable                group . . .  
                        port
```

### **group** *group#*

Suppresses transfer of SDLC Relay frames to or from a specific group (group#).

**port** Suppresses transfer of SDLC Relay frames to or from a specific local or remote port.

#### **Example: disable port**

Local group number: [1]?  
(L)ocal port or (R)emote port: [L]?

#### **Group number**

The group number of the local group that includes the port.

#### **Local or remote**

Designates whether the port is local or remote.

## Enable

Use the **enable** command to turn on data transfer for an entire group or a specific local interface port.

### **Syntax:**

```
enable  
      group . . .  
      port
```

### **group** *group#*

Allows transfer of SDLC Relay frames to or from the specified local group (group#).

### **port**

Allows transfer of SDLC Relay frames to or from the specified local or remote port.

#### **Example: enable port**

Local group number: [1]?  
(L)ocal port or (R)emote port: [L]?

#### **Group number**

The group number of the group that includes the port.



## Configuring and Monitoring SDLC Relay

### Local or remote

Designates whether the port is local or remote.

### List (for network SRLY)

Use the **list** command to display the configuration of the SDLC Relay (SRLY) interface.

#### Syntax:

**list**

#### Example:

```
list
Maximum frame size in bytes = 2048
Encoding: NRZ
Idle State: Flag
Clocking: External
Cable Type: RS-232 DTE
Speed (bps): 0
Transmit Delay Counter: 0
```

#### Maximum frame size in bytes

Maximum frame size that can be sent over the link. The maximum frame size must be large enough to accommodate the largest frame and the 6 byte SRLY header.

#### Encoding

The transmission encoding scheme for the serial interface. Scheme is NRZ (non-return to zero) or NRZI (non-return to zero inverted).

#### Idle State

The data link idle state: flag or mark.

#### Clocking

The type of clocking: internal, external.

#### Cable Type

The serial interface cable type.

#### Speed (bps)

Lists the speed of the transmit and receive clocks.

#### Transmit Delay Counter

Number of flags sent between consecutive frames.

### List (for protocol SDLC Relay)

Use the **list** command to display the configuration of a specific group or of all groups.

#### Syntax:

```
list                                all
                                   group . . .
```

**all** Displays the configurations of all local groups.

#### Example: list all

```
SDLC/HDLC Relay Configuration
```

```
Local group      = 1
```

```
Group Name       = CHICAGO-TO-MIAMI
```

## Configuring and Monitoring SDLC Relay

Group Type	= MULTI	Enabled	= YES
Local port	= PRIMARY	Enabled	= YES
Interface	= 2		
Remote port	= SECONDARY	Enabled	= YES
Remote group	= 1	Addressing	= 2-BYTE
IP Address	= 9.67.2.3	Code level	= CURRENT
Local group	= 2		
Group Name	= CHICAGO-TO-RALEIGH		
Group Type	= MULTI	Enabled	= YES
Local port	= PRIMARY	Enabled	= YES
Interface	= 3		
Remote port	= SECONDARY	Enabled	= YES
Remote group	= 2	Addressing	= 2-BYTE
IP Address	= 9.67.2.3	Code level	= CURRENT
Local group	= 3		
Group Name	= CHICAGO-TO-PITTSBURGH		
Group Type	= PT-PT	Enabled	= YES
Local port	= PRIMARY	Enabled	= YES
Interface	= 4		
Remote port	= SECONDARY	Enabled	= YES
Remote group	= 3	Addressing	= 2-BYTE
IP Address	= 9.67.2.4	Code level	= CURRENT

### Local group

Indicates the local group number.

### Group Name

Indicates the local group name.

### Group Type

Indicates the local group type, which is point-to-point or multipoint.

### Local port

Indicates whether the port is primary or secondary and its status, enabled or disabled.

### Interface

Indicates the network or interface number of the local port. This number matches the number displayed using the **Config list devices** command.

### Remote port

Indicates whether the remote port is primary or secondary and its status, enabled or disabled.

### Remote group

Indicates the group number of the remote group.

### Addressing

Indicates whether one-byte or two-byte addressing is used.

### IP address

Indicates the internal IP address of the remote router for this group. It identifies the IP tunnel that connects the router to the remote router.

### Code level

Indicates the code level, whether current or migration. The code level determines the range of numbers that can be used to identify the groups. Current code level has a range of 1 to 255; migration code level has a range of 0 to 15.

### **group** *group#*

Displays the configuration of a specified group.

## Set

Use the **set** command to configure the SRLY interface parameters.

### Syntax:

```
set
    cable
    clocking
    encoding
    frame-size
    idle
    speed
    transmit-delay
```

**cable** Sets the cable used on the serial interface. The options are:

- RS-232 DTE
- RS-232 DCE
- V35 DTE
- V35 DCE
- V36 DTE
- V36 DCE
- X21 DTE
- X21 DCE

Table 86 lists the cable types you can configure on the various adapters.

Table 86. Cable Types for 2216 Interfaces

Adapter Type	Cable Type
8-port EIA 232	RS-232 DTE and RS-232 DCE
6-port V.35/V36	V.35 DCE, V.35 DTE, V.36 DCE, or V.36 DTE
8-port X.21	X.21 DCE and X.21 DTE

### Example:

```
set cable V35 dte
```

A DTE cable is used when you are attaching the router to some type of DCE device (for example, a modem or a DSU/CSU).

A DCE cable is used when the router is acting as the DCE and providing the clocking for direct attachment.

### clocking *internal or external*

To connect to a modem or DSU, configure external clocking and select the appropriate DTE cable with the **set cable** command.

To connect directly to another DTE device, configure internal clocking, select the appropriate DCE cable with the **set cable** command, and configure the clocking/line speed with the **set speed** command.

**Default:** external

### Example:

```
set clocking internal
```

### encoding *nrz or nrzi*

Configures the SRLY interface's encoding scheme as NRZ (Non-Return to Zero) or NRZI (Non-Return to Zero Inverted). NRZ is the default.

## Configuring and Monitoring SDLC Relay

### Example:

```
set encoding nrz
```

### frame-size

Configures the maximum size of the frames that can be transmitted and received on the data link. If this value is set to a larger value than that specified with the add remote-secondary command, then this value is changed to reflect that maximum. The IBM 2216 generates an ELS message warning the user that this value is changing. The user will continue receiving this ELS message until it is changed in the SRAM configuration. Valid entries are shown in Table 87.

**Note:** The frame size must be large enough to accommodate the largest frame received plus a 15-byte SRLY header.

Table 87. Valid Values for Frame Size in Set Frame-Size Command

Minimum	Maximum	Default
128	8187	2048

### idle flag

Configures the transmit idle state for framing on the SRLY interface. The default is the flag option which provides continuous flags (7E hex) between frames.

The link will receive a flag idle transparently.

### idle mark

Configures the transmit idle state for framing on the SRLY interface. The mark option puts the line in a marking state (OFF, 1) between frames.

The link will receive a mark idle transparently.

### speed

For internal clocking, use this command to specify the speed of the transmit and receive clock lines.

For external clocking, this command does not affect the operation of the WAN/serial line.

#### Valid Values:

Internal Clocking: See Table 88

External Clocking: See Table 89

Table 88. Line Speeds When Internal Clocking is Used for 2216 Interfaces

Adapter Type	Speed Range
8-port EIA 232	9600 to 64 000 bps
6-port V.35/V.36	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps
8-port X.21	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps

Table 89. Line Speeds When External Clocking is Used for 2216 Interfaces

Adapter Type	Speed Range
8-port EIA 232	2400 to 64 000 bps
6-port V.35/V.36	2400 to 2 048 000 bps
8-port X.21	2400 to 2 048 000 bps

### transmit-delay value

Allows the insertion of a delay between transmitted packets. This command

## Configuring and Monitoring SDLC Relay

ensures a minimum delay between frames so that it is compatible with older, slower serial devices at the other end. This value is specified as the number of flag bytes that should be sent between consecutive frames. The range is 0 to 15. The default is 0.

**Note:** If you configure a non-zero transmit delay for a SDLC Relay interface on the 8-port EIA- 232E adapter, 6-port V.35/V.36 adapter, or 8-port X.21 adapter, you must configure the line speed using the **set speed** command.

---

## Accessing the SDLC Relay Monitoring Environment

To monitor information related to the SDLC Relay interface, access the interface monitoring process by doing the following:

1. Enter the **status** command to find the PID for GWCON. (See page 9 for sample output of the **status** command.)
2. At the OPCON prompt, enter the **talk** command and the PID for GWCON. For example:

```
* talk 5  
+
```

The GWCON prompt (+) is displayed on the console. If the prompt does not appear when you first enter GWCON, press **Return** again.

3. At the GWCON prompt, enter the **configuration** command to see the protocols and networks for which the router is configured. For example:

```
+ configuration
```

See page 112 for more sample output from the **configuration** command.

4. Enter the **protocol sdlc** command. For example:

```
+ prot sdlc  
SDLC Relay>
```

The SDLC Relay prompt is displayed on the console. You can then view information about the SDLC Relay groups by entering the SDLC Relay monitoring commands.

---

## SDLC Relay Monitoring Commands

This section summarizes and then explains the SDLC Relay monitoring commands. The SDLC Relay monitoring commands allow you to view parameters for interfaces transmitting SDLC Relay frames. Some of these commands, such as **enable** and **disable** also take effect operationally, but they do not affect the configuration. The SDLC Relay> prompt is displayed for all SDLC Relay monitoring commands. Table 90 shows the commands.

*Table 90. SDLC Relay Monitoring Commands Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Clear-Port-Statistics	Clears SDLC Relay statistics for the specified port.
Disable	Temporarily suppresses groups and ports.
Enable	Temporarily turns on groups and ports.
List	Displays entire SDLC Relay and group specific configurations.

## Configuring and Monitoring SDLC Relay

Table 90. SDLC Relay Monitoring Commands Summary (continued)

Command	Function
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Clear-Port-Statistics

Use the **clear-port-statistics** command to discard the SDLC Relay statistics for all ports. The statistics include counters for packets forwarded and packets discarded.

#### Syntax:

**clear-port-statistics**

**clear-port-statistics**

Clears port statistics gathered since the last time you restarted the router or cleared statistics.

#### Example:

```
clear-port-statistics
Clear all port statistics? (Yes or No): Y
```

### Disable

Use the **disable** command to suppress data transfer for an entire group or a specific relay port. SRAM (static read access memory) does not permanently store the effects of the **disable** monitoring command. Therefore when you restart the router, the effects of this command are erased.

#### Syntax:

```
disable                group . . .
                        port
```

**group** *group#*

Suppresses transfer of SDLC Relay frames to or from the specified local group (group#).

**port** Suppresses transfer of SDLC Relay frames to or from the specified local or remote port.

### Enable

Use the **enable** command to turn on data transfer for an entire group or a specific local interface port. SRAM does not permanently store the effects of the **enable** monitoring command. Therefore when you restart the router, the effects of this command are erased.

#### Syntax:

```
enable                group . . .
                        port
```

**group** *group#*

Allows transfer of SDLC Relay frames to or from the specified local group (group#).

**port** Allows transfer of SDLC Relay frames to or from the specified local or remote port.

## List

Use the **list** command to display the configuration of a specific group or of all groups.

### Syntax:

```
list group . . .
```

**all** Displays the configurations of all local ports.

### Example:

```
list all
SDLC/HDLC Relay Configuration
```

```
Local group      = 1
Group Name       = CHICAGO-TO-MIAMI
Group Type       = MULTI                               Enabled    = YES
Local port      = PRIMARY                             Enabled    = YES
Interface        = 2
Remote port      = SECONDARY                          Enabled    = YES
Remote group     = 1                                  Addressing = 2-BYTE
IP Address       = 9.67.2.3                           Code level = CURRENT

Local group      = 2
Group Name       = CHICAGO-TO-RALEIGH
Group Type       = MULTI                               Enabled    = YES
Local port      = PRIMARY                             Enabled    = YES
Interface        = 3
Remote port      = SECONDARY                          Enabled    = YES
Remote group     = 2                                  Addressing = 2-BYTE
IP Address       = 9.67.2.3                           Code level = CURRENT

Local group      = 3
Group Name       = CHICAGO-TO-PITTSBURGH
Group Type       = PT-PT                               Enabled    = YES
Local port      = PRIMARY                             Enabled    = YES
Interface        = 4
Remote port      = SECONDARY                          Enabled    = YES
Remote group     = 3                                  Addressing = 2-BYTE
IP Address       = 9.67.2.4                           Code level = CURRENT
```

### Local group

Indicates the local group number.

### Group Name

Indicates the local group name.

### Group Type

Indicates the local group type, which is point-to-point or multipoint.

### Local port

Indicates whether the port is primary or secondary and its status, enabled or disabled.

### Interface

Indicates the network or interface number of the local port. This number matches the number displayed using the Talk 6 **list devices** command or the Talk 5 **config** command.

### Remote port

Indicates whether the remote port is primary or secondary and its status, enabled or disabled.

### Remote group

Indicates the group number of the remote group.

### Addressing

Indicates whether one-byte or two-byte addressing is used.

## Configuring and Monitoring SDLC Relay

### IP address

Indicates the internal IP address of the remote router for this group. It identifies the IP tunnel that connects the router to the remote router.

### Code level

Indicates the code level, whether current or migration. The code level determines the upper limit of the range of numbers that can be used to identify the groups.

### **group** *group#*

Displays the configurations of a specified group.

---

## SDLC Relay Interfaces and the GWCON Interface Command

While SDLC Relay interfaces have their own monitoring processes for monitoring purposes, the router also displays complete statistics for installed network interfaces when you use the **interface** command from the GWCON environment. (For more information on the **interface** command, refer to Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands.)

---

## SDLC Relay Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

### CONFIG (Talk 6) Delete Interface

SDLC Relay supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

### GWCON (Talk 5) Activate Interface

SDLC Relay supports the GWCON (Talk 5) **activate interface** command with no restrictions.

All SDLC Relay interface-specific commands are supported by the GWCON (Talk 5) **activate interface** command.

### GWCON (Talk 5) Reset Interface

SDLC Relay supports the GWCON (Talk 5) **reset interface** command with no restrictions.

All SDLC Relay configuration changes are automatically activated except the following:

<b>Commands whose changes are not activated by the GWCON (Talk 5) reset interface command</b>
---

CONFIG, net, set frame-size
-----------------------------

<b>Note:</b> You cannot increase the frame size.
--



---

## Chapter 48. Using SDLC Interfaces

This chapter how to use the SDLC interface and includes the following sections:

- “Basic Configuration Procedure”
- “Configuring Switched SDLC Call-In Interfaces”
- “SDLC Configuration Requirements” on page 676

Enter SDLC configuration commands at the SDLC # Config> prompt (where # identifies the interface you specify with the network command). Changes made to the routers configuration do not take effect immediately, but become part of the router’s static configuration memory when it is restarted.

---

### Basic Configuration Procedure

This section outlines the minimum configuration required for SDLC to be usable by DLSw or by APPN.

Before beginning any configuration procedure, use the **list device** command from the config process to list the interface numbers of different devices. At the config prompt, select the interface you want to configure by entering either: **network interface number** or **n interface number**. If you need any further configuration command explanations, refer to the configuration commands described in this chapter.

---

### Configuring Switched SDLC Call-In Interfaces

A switched SDLC call-in interface allows a PU type 2.0 device to dial into a 2216 using a switched SDLC line, providing an additional connectivity option to your network. The interface is restricted to PU type 2.0 devices and can run DLSw only.

**Note:** You cannot configure APPN over a switched SDLC call-in interface.

To configure a switched SDLC call-in interface:

1. Configure a V.25 bis base network:

```
Config> set data-link v25bis 2
Config> net 2
V25bis Config>
(configuration the V25bis net)
```

See “Chapter 50. Using the V.25 bis Network Interface” on page 701 for more information about configuring V25bis.

**Note:** Any physical layer parameters such as the **encoding type** and **full vs. half duplex** are configured on the V.25 bis interface and not on the Switched SDLC dial circuit interface.

2. Add a dial circuit device:

```
Config> add device dial
```

3. Set the data link for the dial circuit interface to SDLC. In this example, the dial circuit is interface 3.

```
Config> set data-link sdlc 3
```

4. Configure the dial circuit:

```
Config> net 3
Dial circuit config> set net 2 1
Dial circuit config> encapsulator
```

## Using SDLC Interfaces

```
sdlc config>
  (configure SDLC)
sdlc config> exit
Dial circuit config> exit
Config>
```

### 5. Configure DLSw:

```
Config> prot dls
DLSw protocol user configuration
DLSw config> add sdlc
Interface # [0]? 3
SDLC Address or 'sw' (switched dial-in) [sw]? sw 2
Source MAC address [4000112402C1]? 400003174d2
Source SAP in hex [4]?
Destination MAC address [000000000000]? 400000000004 3
Destination SAP in hex [0]? 4 4

XID0 block num in hex (0-0xfff) [0]? 017
XID0 id num in hex (0-0xffff) [0]? 00001
For a switched dial-in link station .....
- PU type is forced to be 2
- Configured XID block/id num is used to override
  fields in the XID0 from the SDLC station
  - if block/id set to zeroes, XID0 is not modified
  - otherwise configured fields are put into XID0
- Poll type is not configured (not used)
DLSw config> li sdlc all
Net Addr  Status  Source SAP/MAC  Dest SAP/MAC  PU  Blk/IdNum  PollFrame
3  FF(sw) Enabled  04 400003174D2  04 400000000004  2  017/00001  TEST

DLSw config> exit
Config>
```

**1** You will not be able to set any other dial circuit parameters as the software will take defaults for all other parameter values. For information about the defaults, see “Encapsulator” on page 746.

**2** Specifying “sw” indicates that this is a switched SDLC call-in interface.

**3** The destination MAC address cannot be all 0s. If you specify or default to a value of 0, the software will prompt you for a valid address.

**4** The destination SAP cannot be 0. If you specify or default to a value of 0, the software will prompt you for a valid address.

See the “Using and Configuring DLSw” and the “Monitoring DLSw” chapters of *Protocol Configuration and Monitoring Reference Volume 1* for additional information about configuring DLSw.

---

## SDLC Configuration Requirements

In addition to the SDLC-specific configuration procedures and commands described in this chapter, you need to configure SDLC in the DLSw or APPN protocol. Only one protocol at a time, DLSw or APPN, may run over a given SDLC interface. In other words, link stations on a given SDLC interface cannot be divided between APPN and DLSw. If a DLSw configuration and an APPN configuration exist for the same SDLC interface, the first protocol to come active will own the SDLC interface.

---

## Chapter 49. Configuring and Monitoring SDLC Interfaces

This chapter describes the SDLC configuration and operational commands. It contains the following sections:

- “Accessing the SDLC Configuration Environment”
- “SDLC Configuration Commands” on page 678
- “Accessing the SDLC Monitoring Environment” on page 690
- “SDLC Monitoring Commands” on page 690
- “SDLC Interfaces and the GWCON Interface Command” on page 699
- “Statistics Displayed for SDLC Interfaces” on page 699

Changes made at the configuration command console (SDLC CONFIG>) become part of the SRAM configuration when you restart the router.

Conversely, SDLC monitoring commands entered within the SDLC monitoring process take effect immediately. However, changes made with monitoring commands do not become part of the router’s static configuration. When the router is restarted, the effects of the monitoring commands are overwritten by the router’s static configuration. Monitoring consists of the following actions:

- Monitoring the protocols and network interfaces that are currently in use by the router
- Making real-time changes to the SDLC configuration without permanently affecting the SRAM configuration
- Displaying ELS (Event Logging System) messages relating to router activities and performance

---

### Accessing the SDLC Configuration Environment

Use the CONFIG process to change the configuration of the router. The new configuration takes effect when the router is restarted.

To enter the configuration process:

1. Enter **talk 6** (or **t 6**), at the OPCON (\*) prompt. This brings you to the CONFIG> prompt as shown in the following example:

```
MOS Operator Console
For help using the Command Line Interface, press ESCAPE, then '?'
* talk 6
CONFIG>
```

If the CONFIG> prompt does not appear immediately, press the **Enter** key again.

All SDLC configuration commands are entered at the SDLC config> prompt. You can use the GWCON t 5 (See “Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands” on page 109) environment to make dynamic configuration changes. However, these changes will disappear when the device is restarted.

2. At the Config> prompt, enter the **set data-link sdlc** command. When prompted, enter the name of the interface to associate with the SDLC device.

```
Config>set data-link sdlc
Interface number [0]? 2
Config>
```

3. Next, enter the **network** command, plus the number of an SDLC interface that you entered earlier.



## Configuring SDLC Interfaces

Enter "A" for 2-WAY-ALTERNATING or "S" for 2-WAY-SIMULTANEOUS [S]?  
Enter router as secondary link station poll pause [0]?  
Enter receive window [7]?  
Enter transmit window [7]?

### Enter station address

The station's SDLC address in the range 01 - FE.

### Enter station name

The name designation of the SDLC station (maximum characters is 8).

### Include station in router as secondary group poll list

Select whether or not to include this station in the secondary group poll list for this interface. The SDLC software supports the IBM 3174 group poll function for SDLC secondary station. You must add a group poll address using the **set link group-poll** command for this parameter to have an affect.

### Enter router as primary group poll address (0 means disable)

Specifies the group address that is to be polled. The Primary Group Poll Address is entered per station.

**Valid Values:** X'00' to X'FE', where 0 indicates not using group poll

**Default Value:** X'00'

### Enter max packet size

The maximum packet size that can be sent to or received from the remote link station. This value cannot be greater than that specified for the link. This value is configured with the **set link frame-size** command.

### Enter "A" for 2-WAY-ALTERNATING or "S" for 2-WAY-SIMULTANEOUS

Specifies whether the link station operates in a 2-way-simultaneous or 2-way-alternating mode. The default is inherited from the interface configuration.

### Enter router as secondary link station poll pause

Specifies the amount of time a secondary station will delay sending poll final after being polled.

#### Notes:

1. This value should be less than the poll timeout for the primary station.
2. Values other than 0 on multipoint links can cause poor response time.

**Valid Values:** 0 to 25.5 seconds in increments of 0.1 seconds

**Default Value:** 0

### Enter receive window

The maximum number of packets that the router can receive without sending an acknowledgement.

**Note:** Ensure that the receive window size is sufficiently large, because the router will disconnect the station if the window size is exceeded. Set the **receive window** to the maximum value for the configured modulo. Unless there is some reason to closely monitor the **receive window** size, it should be set to the maximum value for the modulo being used.

### Enter transmit window

The maximum number of packets that the router can transmit without receiving an acknowledgement.



```

Timers:  XID/TEST response:  2.0 sec
         SNRM response:      2.0 sec
         Poll response:      2.0 sec
         Inter-poll delay:   0.0
         Primary poll pause: 0.5 sec
         Dflt sec poll pause: DISABLED
         RTS hold delay:     DISABLED
         Inactivity timeout: 30.0 sec

Counters: XID/TEST retry:  8
          SNRM retry:      6
          Poll retry:      10
SDLC 1 Config>

```

### Link configuration

The name and status of SDLC link station that are in the router's configuration.

**Role** The primary, secondary, or negotiable role for link stations that you configure using the **set link role** command.

**Type** The type of link, multipoint or point-to-point. If **role** is *secondary*, a value of *multipoint* for this parameter causes RTS to be lowered when not transmitting.

### Duplex

Specifies the hardware capability of the line. For two-way simultaneous link management, *full duplex* hardware capability is required.

### Modulo

The sequence number range to use on the link: MOD 8 (0-7) or MOD 128 (0 - 127).

### Idle state

The bit pattern (FLAG or MARK) transmitted on the line when the interface is not transmitting data.

**Speed** The physical data rate of the interface. When the clocking is internal, this is the data rate generated by the internal clock. This parameter has no effect for externally clocked lines.

### Group Poll

Address used for the group poll feature. Secondary stations having group inclusion coded as *yes* will respond to unnumbered polls received from this address. This address must be non-zero for the group poll feature to be in effect for any secondary stations under this link. Each secondary station will still have a specific station address in addition to the group address.

**Cable** Specifies the type of cable in use (RS-232, V.35, V.36, or X.21).

### Encoding

Configures the SDLC transmission encoding scheme as NRZ (Non-Return to Zero) or NRZI (Non-Return to Zero Inverted).

### Clocking

Interface clocking, external or internal.

### Frame Size

The maximum frame size that can be sent over the interface.

### Timers:

All the timers listed below have a 100ms resolution.

### XID/TEST resp.

The time to wait for an XID or TEST response message before retransmitting the XID or TEST frame. A value of 0 indicates that the router will not delay the retry past its next poll list turn.

## Configuring SDLC Interfaces

### SNRM response

The maximum time to wait for a UA response message before the station retransmits SNRM(E).

### Poll response

The maximum time to wait for a response from any polled station before retrying.

### Inter-poll delay

The amount of time the router (with a primary role) waits after receiving a response, before polling the next station.

**Note:** Primary Poll Pause is the preferred poll timer. Inter-Poll Delay causes end user response time problems. See page 686 for more information about primary poll pause.

### Interframe delay

Specifies an amount of time to inject flags between frames. The maximum value of 120 injects about 15 flags between frames for a 9600 baud line.

### Leading Flags

The number of flags sent if the interframe delay is not sufficient for a response to the device on the other end of this link. This is a time unit with a maximum value of 100.

### Inactivity timeout

For idle NRM/E secondary stations, sets the time after which the interface changes the station to its recovery state. A 0 (zero) causes the station to remain idle indefinitely.

### Counters:

### XID/TEST retry

The maximum number of times the router sends an XID or TEST frame without receiving a response before timing out. A value of 0 indicates that the router will retry indefinitely.

**SNRM** The maximum number of times the router will send an SNRM(E) frame without receiving a response before timing out. A value of 0 indicates that the router will retry indefinitely.

### Poll retry

The maximum number of times the router polls the station without receiving a response before timing out. A value of 0 indicates that the router will continue to retry indefinitely.

**Note:** Physical layer parameters such as **duplex type**, **speed**, **cable type**, **encoding**, **clocking**, **leading flags**, and **inter-frame delay** do not apply for SDLC dial circuit interfaces and are not displayed by the **list link** command.

**station** *all or address or link station name*

Displays information for the specified SDLC link station or for all link stations.

### Example:

```
list station c1
Addr-A/S      Name      Status      Max BTU      Rx Window      Tx Window      Secondary      Primary
(Sec Gp)                               -----      -----      -----      -----      -----
C1   A SDLC_C1  ENABLED      2048          7              7              0.0 sec       00
```

### Example:



## Configuring SDLC Interfaces

**list station all**

Addr-A/S (Sec Gp)	Name	Status	Max BTU	Rx Window	Tx Window	Secondary Poll Pause	Primary GP Addr
C1	A SDLC_C1	ENABLED	2048	7	7	0.0 sec	00
C2	A SDLC_C2	ENABLED	2048	1	7	0.0 sec	00

### Address

The address of the SDLC link station. The address in parentheses is the "router as secondary" Group Address of the interface which is used by the station if the station has group inclusion set, link is secondary, and the secondary group address is non-zero.

**Name** The character string name designation of SDLC link station.

### Status

The status of the SDLC link station, ENABLED or DISABLED.

### Max BTU

The frame size limit of the station. This frame size must not be larger than the maximum Basic Transmission Unit (BTU) packet size configured with the **set link frame-size** command.

### Rx Window

The size of the receive window.

### Tx Window

The size of the transmit window.

## Set

Use the **set** command to configure specific information for one or all SDLC link stations.

### Syntax:

```
set                               link
                                     cable*
                                     clocking*
                                     duplex* . . .
                                     encoding* . . .
                                     frame-size
                                     group poll* ...
                                     idle* . . .
                                     inactivity ...
                                     inter-frame delay*
                                     leading flags*
                                     modulo . . .
                                     name
                                     poll . . .
                                     role* . . .
                                     snrm
                                     speed*
```

## Configuring SDLC Interfaces

```

type* . . .
xid/test
station
address. . .
group-inclusion
gp-address-prim
max-packet
name
protocol
receive-window
secondary-phase
transmit-window

```

**\*Note:** These commands are not available for SDLC dial circuit interfaces.

### link cable *type*

Sets the cable connected to this interface. The options are the following DCE and DTE types: V.36, RS-232, V.35, and X.21.

Table 92 lists the cable types you can configure on the various adapters.

Table 92. Cable types for 2216 Interfaces

Adapter Type	Cable Type
8-port EIA 232	RS-232 DTE and RS-232 DCE
6-port V.35/V36	V.35 DCE, V.35 DTE, V.36 DCE, or V.36 DTE
8-port X.21	X.21 DCE and X.21 DTE

A DTE cable is used when you are attaching the router to some type of DCE device (for example, a modem or a DSU/CSU).

A DCE cable is used when the router is acting as the DCE and providing the clocking for direct attachment.

### link clocking *internal or external*

To connect to a modem or DSU, configure external clocking and select the appropriate DTE cable with the **set link cable** command.

To connect directly to another DTE device, configure internal clocking, select the appropriate DCE cable with the **set link cable** command, and configure the clocking/line speed with the **set link speed** command.

**Default:** external

### link duplex *full or half*

Configures the SDLC line for *full-duplex* or *half-duplex* signaling. *Half-duplex* means that the 2216 raises RTS and expects to see CTS before it will transmit data. *Full-duplex* means that the 2216 does not wait for CTS to be raised before it transmits data.

**Note:** The duplex type does not control how SDLC operates at the SDLC protocol level (two-way simultaneous or two-way alternating).

### link encoding *nrz* or *nrzi*

Configures the SDLC transmission encoding scheme as NRZ (Non-Return to Zero) or NRZI (Non-Return to Zero Inverted). NRZ is the default.

### link frame-size

Configures the maximum size of the frames that can be transmitted and received on the data link. Valid entries are shown in Table 93.

Table 93. Valid Values for Frame Size in Link Frame-Size Command

Minimum	Maximum	Default
128	8187	2048

Set the link frame size greater than or equal to the maximum packet size that you configured with the **set station xxx max packet** command. Otherwise, the router automatically resets the maximum packet size to the link frame size and issues the following ELS message:

```
SDLC.054: nt 3 SDLC/0 Stn xx-MaxBTU too large for Link adjusted (4096->2048)
```

#### Example: set link frame-size

```
Frame size in bytes (128 - 8187)[2048]?
```

### link group-poll

Sets a group poll address for router as secondary stations on the link. The SDLC software supports the IBM 3174 group poll function. Use the **add station** or the **set station group inclusion** command to include a station in the group poll list.

#### Example:

```
set link group-poll
Enter group poll address router as secondary (in hex) [00:]?f3
Group poll support enabled
```

### link idle flag

Configures the transmit idle state for SDLC framing. The default is the flag option which provides continuous flags (7E) between frames.

#### Example: set link idle flag

The link will receive a flag idle transparently.

### link idle mark

Configures the transmit idle state for SDLC framing. The mark option puts the line in a marking state (OFF, 1) between frames.

### link inactivity *#-of-seconds*

For idle NRM/E secondary stations, sets the time after which the interface changes the station to its recovery state. The range is 0 to 7200 seconds. The default is 30. A 0 (zero) causes the station to remain idle indefinitely.

#### Example:

```
set link inactivity
Enter secondary link station inactivity timeout :[30.0]?
```

### link inter-frame delay

Allows the insertion of a delay between transmitted packets. This command ensures a minimum delay between frames for compatibility with older, slower serial devices at the other end. This parameter is the amount of time between frames.

**Valid values:** 0 to 120

**Default value:** 0

## Configuring SDLC Interfaces

### Example:

```
set link inter-frame  
Transmit Delay Counter [0]?
```

### link leading flags

Sets the number of leading flags. Use this command when the inter-frame delay is not sufficient to allow a response from the 2216 to another device. This command should also be used to set a leading flags delay if you are using half-duplex modems that are not capable of receiving a packet as soon as the modem raises the CTS modem signal.

**Valid values:** 0 to 100

**Default value:** 0

### Example:

```
set link leading flags  
Leading flags delay [0]?
```

### link modulo 8 or 128

Specifies the sequence number range to use on the link: MOD 8 (0-7) or MOD 128 (0 - 127). Default is MOD 8.

**Note:** When you change this value, the window sizes become invalid. Use the **set station** command to change the receive window and transmit window sizes. Valid window sizes are 0 through 7.

Also, when **link modulo** is 128, a SNRME rather than a SNRM is used at connection start-up and supervisory frame headers are expanded by an additional byte.

### link name

Establishes a character string for the link that you are configuring. This parameter is for informational purposes only.

### Example:

```
set link name  
Enter link name: [LINK_0]?
```

### link poll delay

Sets the time delay between each poll that is sent over the interface. **link poll delay** is less preferred than **link poll ppause**. **link poll delay** puts a delay between every poll, and thus causes response time problems even when the link is lightly utilized. If **link poll ppause** is set > 0, then **link poll delay** must be set to 0.

### Example:

```
set link poll delay  
Enter delay between polls [0]?
```

You can also use the t 5 command set link poll ppause to set **primary poll pause**.

### link poll ppause

Sets the primary poll pause.

This parameter determines the minimum time to restart the polling cycle. For example, if there are 5 stations on a multi-dropped link and all 5 station are polled in 0.2 seconds and PPAUSE is set to 0.5 seconds, then the poll of the first station will wait 0.3 more seconds. If data had been received from some stations, then the time to complete the polling of all 5 station probably would have taken longer than 0.5 seconds and the poll of the first station would not have been delayed.

### Example:

```
set link poll ppause
Enter delay between polls [0.5]?
```

### link poll retry

Sets the number of times the interface retries to poll the secondary SDLC link station before it closes the connection.

### Example:

```
set link poll retry
Enter poll retry count (0 = forever) [10]?
```

### link poll timeout

Sets the amount of time the interface waits for a poll response before timing out.

### Example:

```
set link poll timeout
Enter poll timeout [2.0]?
```

### link role *primary or secondary or negotiable*

Configures the interface as an SDLC primary, secondary, or negotiable link station (default is primary).

### Notes:

1. For DLSw, **negotiable** uses X'FF' (broadcast address) for the initial poll. When using broadcast address to negotiate the role, the link initially uses a default SDLC configuration and then resolves to a configured station if the specific address matches. When **primary** is the link role, the link performs an initial poll to a specific address.
2. For APPN point-to-point or negotiable, the broadcast address is used for the initial poll. For primary multipoint, the specific address is used.
3. For switched SDLC, the device must be primary, so **link role type** is not configurable for SDLC dial circuit interfaces.

### link snrm *timeout or retry*

Configures the following SNRM(E) information for primary stations:

#### timeout

The time to wait for an Unnumbered Acknowledgements (UA) response before retransmitting an SNRM(E).

**retry** The number of times to retransmit an SNRM(E) without receiving a response before giving up.

### Example:

```
set link snrm timeout
Enter SNRM response timeout [2.0]?
```

### Example:

```
set link snrm retry
Enter SNRM retry count (0=forever) [6]?
```

### link speed

For internal clocking, use this command to specify the speed of the transmit and receive clock lines.

For external clocking, this command does not affect the operation of the WAN/serial line.

### Valid Values:

## Configuring SDLC Interfaces

Internal Clocking: See Table 94

External Clocking: See Table 95

Table 94. Line Speeds When Internal Clocking is Used for 2216 Interfaces

Adapter Type	Speed range
8-port EIA 232	9600 to 64 000 bps
6-port V.35/V.36	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps
8-port X.21	9600 to 460 800 bps, 1 544 000 bps, or 2 048 000 bps

Table 95. Line Speeds When External Clocking is Used for 2216 Interfaces

Adapter Type	Speed range
8-port EIA 232	2400 to 64 000 bps
6-port V.35/V.36	2400 to 2 048 000 bps
8-port X.21	2400 to 2 048 000 bps

### Example:

```
set link speed  
Line Speed [64000]?
```

### link type *multipoint* or *point-to-point*

Configures the SDLC link to either a multipoint link or a point-to-point link. If the router is secondary, this parameter determines whether RTS is controlled.

**Note:** For switched SDLC, the link is always point-to-point, so **link type** is not configurable for SDLC dial circuit interfaces.

### link xid/test *timeout* or *retry*

Configures the following XID/test information for primary stations:

#### timeout

The maximum amount of time to wait for an XID or TEST frame response before retransmitting the XID or TEST frame.

**retry** The maximum number of times an XID or TEST frame is resent before giving up. A 0 (zero) causes the router to retry indefinitely.

### remote-secondary *address* or *link\_station\_name address <argument>*

Changes the remote station's SDLC address in the range 02 - FE.

**Example:** set remote-secondary SDLC\_C1 address ce

### station *address* or *name address*

Changes the station's SDLC address in the range 01 to FE.

#### Example:

```
set station c1 address  
Enter station address (in hex) [C1]?
```

### station *address* or *link station name group-inclusion no* or *yes*

For SDLC secondary stations, set whether to include this station in the group poll list for this link. For this to be effective, add a secondary group poll address using the **set link group-poll** command.

**Example:** set station c1 group-inclusion yes

### station *gr-address-prim*

Specifies the router as primary group address that is to be polled. A specific address cannot also be used as a group address.

**Valid Values:** X'00' to X'FE', where X'00' indicates not using group poll

**Default Value:** X'00'

### **station** *address or name* **max-packet**

The maximum size of the packet that the station can receive (default: 2048). Do not set the maximum packet size larger than the link frame size that is configured with the **set link frame-size** command; if you do, the router automatically resets the maximum packet size to the link frame size and issues the following ELS message:

```
SDLC.054: nt 3 SDLC/0 Stn xx-MaxBTU too large for Link adjusted (4096->2048)
```

#### **Example:**

```
set station c1 max-packet
Enter max packet size [2048]?
```

### **station** *address or name* **name**

The name of the SDLC station.

#### **Example:**

```
set station c1 name
Enter station name [SDLC_C1]?
```

### **station** **protocol**

Defines whether the station runs as 2-way-alternating (TWA) or 2-way-simultaneous (TWS).

**Note:** TWS requires full-duplex hardware.

### **station** *address or name* **receive window**

The maximum number of frames the router can receive before sending a response. The range is 1 to 7. The default is 7.

#### **Example:**

```
set station c1 receive-window
Enter receive window [7]?
```

**Note:** Ensure that the receive window size is sufficiently large, because the router will disconnect the station if the window size is exceeded. Set the **receive window** to the maximum value for the configured modulo.

### **station** **secondary-pause**

Specifies the amount of time the secondary station will delay sending poll final after being polled.

#### **Notes:**

1. This value should be less than the poll timeout for the primary station.
2. Values greater than 0 on multipoint links can cause poor response time.

**Valid Values:** 0 to 25.5 seconds in increments of 0.1 seconds. A value greater than 0 is most useful on TWS point-to-point links since it allows both directions to send at the same time.

**Default Value:** 0

### **station** *address or name* **transmit-window**

The maximum number of frames the router can transmit before receiving a response frame. The range for MOD 8 is 1 to 7. The range for MOD 128 is 8 to 127.

#### **Example:**

```
set station c1 transmit-window
Enter transmit window [7]?
```

---

### Accessing the SDLC Monitoring Environment

The monitoring environment is the GWCON process. To enter the GWCON process:

1. Enter **talk 5** (or **t 5**) at the OPCON (\*) prompt. This brings you to the GWCON (+) prompt as shown in the following example:

```
MOS Operator Console
For help using the Command Line Interface, press ESCAPE, then '?'
* talk 5
+
```

2. Next, enter the **network #** command using the number that identifies the interface that you previously configured for the SDLC device.

```
+ network 2
SDLC Console
SDLC-2>
```

You enter all GWCON (Monitoring) commands at the + prompt.

Refer to “Chapter 1. Getting Started” on page 3 for information related to the monitoring environment.

---

### SDLC Monitoring Commands

This section summarizes and then explains the SDLC console and related commands. Use these commands to gather information from the database. Table 96 lists SDLC monitoring commands and their function.

*Table 96. SDLC Monitoring Commands Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Add	Adds an SDLC link station
Clear	Clears the counters on the SDLC interface.
Delete	Dynamically removes an SDLC link station.
Disable	Disables connections to one SDLC link station.
Enable	Enables connections to one SDLC link station.
List	Displays SDLC link stations configurations and link station information.
Msgsz	Permits monitoring bytes in data not otherwise visible. Between 12 and 50 bytes for SDLC ELS messages 50 - 53 can be displayed.
Set	Configures specific interface and link station information.
Test	Tests the link between the router and the SDLC link station.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Add

Use the **add** command to add an end station. The router is, by default the primary end station. If you do not use this command and if you configured an SDLC station in DLSw or APPN, the end station is added for you.

#### Syntax:

```
add station
```





## Monitoring SDLC Interfaces

### List

Use the **list** command to display statistics specific to the data link layer and the interface.

#### Syntax:

```
list                link configuration  
                    link counters  
                    station . . .
```

#### link configuration

Displays information for all configured SDLC link stations on the interface.

For an example and for additional information on the **list** command, see “List” on page 680.

**link counters** Displays information for the SDLC counters since the last router restart or the last clear counters.

#### I-Frames

Total number of Information frames received and transmitted.

#### I-Bytes

Total number of Information bytes received and transmitted.

#### Re-Xmit

Total number of frames that were retransmitted.

#### UI-Frames

Total number of Unnumbered Information frames received and transmitted.

#### UI-Bytes

Total number of Unnumbered Information bytes received and transmitted.

**RR** Total number Receive-Ready (RRs) received and transmitted.

**RNR** Total number Receive-Not-Ready (RNRs) received and transmitted.

**REJ** Total number of Rejects received and transmitted.

**UP** Unnumbered Polls (group poll) received and transmitted.

#### **station** *all or address or link station name*

Displays the status of the specified SDLC link station or all stations. The software displays an \* next to the stations that were not explicitly configured using the **add station** command but were added to the configuration because they were defined and activated in the protocol layer (DLSw or APPN).

Displays information for the specified SDLC link station (link station name) on the interface.

#### Address

The address of the SDLC link station. The address in parentheses is the group address of the station. A (00) indicates that a group address is not defined.

## Monitoring SDLC Interfaces

**Name** The character string name designation of SDLC link station.

### Status

The status of the SDLC link station:

#### Enabled

Enabled, but not allocated

#### Idle

Allocated, but not in use

#### Connected

Connected

#### Disconnected

Disconnected

#### Connecting

Connection establishment in progress.

#### Discnectng

Disconnection in progress

#### Recovering

Attempting to recover from a temporary data link error.

### Max BTU

The frame size limit of the remote station. This frame size must not be larger than the maximum Basic Transmission Unit (BTU) packet size configured with the **set link frame-size** command. The default is 2048 bytes.

### Rx Window

The size of the receive window.

### Tx Window

The size of the transmit window.

### **station name or address counters**

Displays frame transmit and receive counts for the specified link station.

#### I-Frames

Number of information frames received and transmitted

#### I-Bytes

Number of information bytes received and transmitted

#### Re-Xmit

Number of frames retransmitted

#### UI-Frames

Number of Unnumbered Information frames received and transmitted

#### UI-Bytes

Number of Unnumbered Information bytes received and transmitted

#### XID-Frames

Number of Exchange Identification frames received and transmitted

#### RR

Number of Receive Ready frames received and transmitted

## Monitoring SDLC Interfaces

- RNR** Number of Receive Not Ready frames received and transmitted
- REJ** Number of Rejects received and transmitted
- TEST** Number of Test frames received and transmitted
- SNRM** Number of Set Normal Response Mode frames received and transmitted
- DISC** Number of Disconnect frames received and transmitted
- UA** Number of Unnumbered Acknowledgment frames received and transmitted
- DM** Number of Disconnected Mode frames received and transmitted
- FRMR** Number of Frame Reject frames received and transmitted
- UP** Unnumbered Polls (group poll) received and transmitted.

### Example:

```
SDLC-2> list link counters
      I-Frames  I-Bytes  Re-Xmit  UI-Frames  UI-Bytes
-----
Send      0          0          0          0          0
Recv      0          0          0          0          0

      RR      RNR      REJ      UP
-----
Send      0          0          0          0
Recv      0          0          0          0

SDLC-2> list station c1
Addr-A/S  Name  Status  Max BTU  Rx Window  Tx Window  Secondary Poll Pause  Primary GP Addr
-----
C1  A SDLC_C1  ENABLED  2048    7          7          0.0 sec  00
```

### Example:

```
SDLC-2> list station all

Addr-A/S  Name  Status  Max BTU  Rx Window  Tx Window  Secondary Poll Pause  Primary GP Addr
-----
C1  A SDLC_C1  ENABLED  2048    7          7          0.0 sec  00
C2  A SDLC_C2  ENABLED  2048    1          7          0.0 sec  00
```

### Example:

```
SDLC-2> list station c1 counters
      I-Frames  I-Bytes  Re-Xmit  UI-Frames  UI-Bytes  XID-Frames
-----
Send      9          384          0          0          0          6
Recv      29         42792          0          0          0          3

      RR      RNR      REJ      TEST      SNRM      DISC
-----
Send      598          0          0          0          1          0
Recv      587          0          0          0          0          0

      UA      DM      FRMR      UP
-----
Send      0          0          0          0
Recv      1          0          0          0
```

## Msgsz

Use the **msgsz** command to display between 12 and 50 bytes of SDLC ELS messages 50 - 53.

**Syntax:****msgsz****Enter between 12 and 50 bytes**

Specifies the number of bytes to be displayed. The default is 12 bytes.

**Set**

Use the **set** command to dynamically configure specific information for one or all SDLC link stations without affecting the SRAM configuration. In the SDLC monitoring environment, the **set** command can be executed only on disabled links or stations. All time values are entered in seconds, with a 0.1 second resolution.

**Syntax:**

```

set                               link
                                     group poll* ...
                                     inactivity ...
                                     modulo . . .
                                     name
                                     poll . . .
                                     protocol . . .
                                     role* . . .
                                     secondary-pause . . .
                                     snrm
                                     type* . . .
                                     xid/test
                                     station
                                     address. . .
                                     group-inclusion
                                     gp-address-prim
                                     max-packet
                                     name
                                     protocol
                                     receive-window
                                     secondary-pause
                                     transmit-window

```

**\*Note:** These commands are not supported on SDLC dial circuit interfaces.

**link group-poll address**

Sets a group poll address for secondary stations on the link. The SDLC software supports the IBM 3174 group poll function. Use the **add station** or the **set station group inclusion** command to include a station in the group poll list.

**Example:**

## Monitoring SDLC Interfaces

```
set link group-poll
Enter group poll address (in hex) [00:]?f3
Group poll support enabled
```

### link inactivity

For idle NRM/E secondary stations, sets the time after which the interface changes the station to its recovery state. The range is 0 to 7200 seconds. The default is 30. A 0 (zero) causes the station to remain idle indefinitely.

#### Example:

```
set link inactivity
Enter secondary link station inactivity timeout :[30.0]?
```

### link modulo

Dynamically changes the range of sequence numbers to be used on the data link without affecting the SRAM configuration. Modulo 8 specifies a sequence number range 0 - 7, and modulo 128 specifies 0 - 127. Default is 8.

**Note:** When you change this value, the transmit and receive window sizes become invalid. Use the **set station** command to change the receive-window and transmit-window sizes.

### link name

Dynamically changes the name of the link without affecting the SRAM configuration. A maximum of 8 characters can be entered. This parameter is for informational purposes only.

#### Example:

```
set link name
Enter link name: [LINK_0]?
```

### link poll delay or timeout or retry

Dynamically changes the following poll information without affecting the SRAM configuration.

**delay** Configures the delay between each poll that is sent over the interface.

#### timeout

Configures the amount of time the router waits for a poll response before timing out.

**retry** Configures the number of times the interface retries to poll the remote SDLC link station before it closes the connection.

#### Example:

```
set link poll delay
Enter delay between polls [0.2]?
```

### link protocol

Defines whether the station runs as TWA or TWS.

**Note:** TWS requires full-duplex hardware.

### link role *primary, secondary, or negotiable*

Configures the interface as an SDLC primary, secondary, or negotiable link station. The default is primary. Use of this command does not affect the SRAM configuration.

#### Notes:

1. For DLSw, **negotiable** uses X'FF' (broadcast address) for the initial poll.

## Monitoring SDLC Interfaces

When using broadcast address to negotiate the role, the link uses a default SDLC configuration.

When **primary** is the link role, the link performs an initial poll to a specific address.

2. For APPN point-to-point or negotiable, the broadcast address is used for the initial poll. For primary multipoint, the specific address is used.
3. For switched SDLC, the device must be primary, so **link role type** is not configurable for SDLC dial circuit interfaces.

### link secondary-pause

Specifies the amount of time the secondary station will delay sending poll final after being polled.

#### Notes:

1. This value should be less than the poll timeout for the primary station.
2. Values greater than 0 on multipoint links can cause poor response time.

**Valid Values:** 0 to 25.5 seconds in increments of 0.1 seconds. A value of > 0 is most useful on TWS point-to-point links since it allows both directions to send at the same time.

**Default Value:** 0

### link snrm *timeout or retry*

For primary stations, dynamically changes the following SNRM(E) information without affecting the SRAM configuration.

#### timeout

The time to wait for an Unnumbered Acknowledgment (UA) response before retransmitting an SNRM(E).

**retry** The number of times to retransmit an SNRM(E) without receiving a response before giving up.

#### Example:

```
set link snrm timeout
Enter SNRM response timeout [2.0]?
```

### link type *multipoint or point-to-point*

Dynamically changes the SDLC link to either a multipoint link or a point-to-point link without affecting the SRAM configuration.

**Note:** For switched SDLC, the link is always point-to-point, so **link type** is not configurable for SDLC dial circuit interfaces.

### link xid/test *timeout or retry*

For primary stations, dynamically changes the following XID/test information without affecting the SRAM configuration.

#### timeout

The maximum amount of time to wait for an XID or TEST frame response before retransmitting the test frame.

**retry** The maximum number of times an XID or TEST frame is resent before giving up. A 0 (zero) causes the router to retry indefinitely.

**Note:** Examples for, and explanations of, the following parameters can be found in the SDLC configuration chapter at "Set" on page 683.

## Monitoring SDLC Interfaces

### **station** *address or name* **address**

Changes the station's SDLC address.

### **station** **group-inclusion**

For SDLC secondary stations, set whether to include this station in the group poll list for this link. For this to be effective, add a secondary group poll address using the **set link group-poll** command.

**Example:** **set station c1 group-inclusion yes**

### **station** **gp-address-prim**

Specifies the group address that is to be polled. A specific address cannot also be used as a group address.

**Valid Values:** X'00' to X'FE', where X'00' indicates not using group poll

**Default Value:** X'00'

### **station** *address or name* **max-packet**

Maximum size of packet that this station can receive.

### **station** *address or name* **name**

Name of the SDLC station.

### **station** **protocol**

Defines whether the station runs as TWA or TWS.

**Note:** TWS requires full-duplex hardware.

### **station** *address or name* **receive-window**

Maximum number of frames the router receives before an acknowledgement is required.

### **station** **secondary poll pause**

Specifies the amount of time the secondary station will delay sending poll final after being polled.

#### **Notes:**

1. This value should be less than the poll timeout for the primary station.
2. Values greater than 0 on multipoint links can cause poor response time.

**Valid Values:** 0 to 25.5 seconds in increments of 0.1 seconds. A value greater than 0 is most useful on TWS point-to-point links since it allows both directions to send at the same time.

**Default Value:** 0

### **station** *address or name* **transmit-window**

Maximum number of frames router transmits before receiving a response frame.

## Test

Transmits a specified number of TEST frames to the specified station and waits for a response. Use this command to test the integrity of the connection. Press any key to cancel the test.

**Note:** Disable the specified link station before using this command

#### **Syntax:**

**test** *station name or address #frames-to-send*  
*frame-size*



**Example:**

```
test station c1
Number of frames to send [1]? 5
Frame length [265]?
Starting echo test -- press any key to abort
5 frames sent, 5 frames received, 0 compare errors, 0 timeouts
```

**Number of test frames to send**

Total number of frames to send.

**Frame length**

Length of frames to be sent. Frame length cannot be larger than the maximum frame length of the specified station.

The test may be aborted by pressing any key.

---

## SDLC Interfaces and the GWCON Interface Command

While the SDLC interface has a console process for operational purposes, the 2216 also displays complete statistics for installed interfaces when you use the **interface** command from the GWCON environment. (For more information on the interface command, refer to “Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands” on page 109.)

### Statistics Displayed for SDLC Interfaces

Using the **interface** command, you can display statistics for SDLC devices without entering the SDLC monitoring process. To do this, enter the **interface** command and an interface number at the + prompt.

```
+ interface 12
```

This command lists statistics in the following format:

Nt	Nt'	Interface	Slot-Port	Self-Test Passed	Self-Test Failed	Maintenance Failed
12	12	SDLC/0	Slot: 8 Port: 2	2	1	0
SDLC MAC/data-link on V.35/V.36 interface						
Adapter cable:		V.35 DTE				
V.24 circuit:		105 106 107 108 109				
Nicknames:		RTS CTS DSR DTR DCD				
PUB 41450:		CA CB CC CD CF				
State:		ON ON ON ON ON				
Line speed:		64.000 Kbps				
Last port reset:		1 hour, 20 minutes, 42 seconds ago				
Input frame errors:						
		CRC error	0	alignment (byte length)		0
		missed frame	182	too long (> 2062 bytes)		0
		aborted frame	0	DMA/FIFO overrun		0
Output frame counters:						
		DMA/FIFO underrun errors	0	Output aborts sent		0

**Nt** Indicates the interface number as assigned by software during initial configuration.

**Nt'** Indicates the interface number as assigned by software during initial configuration.

**Note:** For SDLC interfaces, the Nt' interface number is always the same as the Nt interface number.

**Slot** Indicates the slot number of the interface that is running SDLC.

## Monitoring SDLC Interfaces

**Port** Indicates the port number of the interface that is running SDLC.

**Self-test passed**

Indicates the total number of times the SDLC interface passed its self-test.

**Self-test failed**

Indicates the total number of times the SDLC interface was unable pass its self-test.

**Maintenance failed**

Indicates the number of maintenance failures.

The following parameters are displayed only if a cable is connected. The information displayed depends on the cable that is connected. Different parameters are displayed with other cables.

**Adapter cable**

Indicates the type of adapter cable that the level converter is using.

**V.24 circuit**

Indicates the circuits being used on the V.24.

**Nicknames**

Indicates the signals being used on the V.24 circuit.

**RS-232**

The EIA 232 (RS 232) circuit names.

**State** Indicates the state of V.24 circuits, signals, and pin assignments (ON or OFF).

**Line speed (configured)**

Indicates the currently configured line speed for the SDLC interface.

**Last port reset**

Indicates how long ago the port was last reset.

**Input frame errors**

Indicates the input frame error type (CRC error, too short, aborted, alignment, too long, DMA/FIFO overrun) and the total number of errors that have occurred.

**Output frame counters**

Indicates the total number of DMA/FIFO overruns and output aborts sent for output frames.

**Missed frame**

When a frame arrives at the device and there is no buffer available, the hardware drops the frame and increments the missed frame counter.

**L & F bits not set**

On serial interfaces, the hardware sets input-descriptor information for arriving frames. If the buffer can accept the complete frame upon arrival, the hardware sets both the Last and First bits of the frame, indicating that the buffer accepted the complete frame. If either of the bits is not set, the packet is dropped, the L & F bits not set counter is incremented, and the buffer is cleared for reuse.

**Note:** It is unlikely that the L & F bits not set counter will be affected by traffic.

---

## Chapter 50. Using the V.25 bis Network Interface

The V.25 bis interface allows routers to establish serial connections over switched telephone lines using V.25 bis modems. This chapter describes how to use the V.25 bis interface. It includes the following sections:

- “Before You Begin”
- “Configuration Procedures”

### Notes:

1. You can assign a destination name to a **connection list** and assign a destination number to each line in the list. When that destination name is called, the numbers in the list are tried one by one until a connection is made or the list is exhausted.
2. V.25 bis is supported only on the 8-port EIA 232 adapter.

---

### Before You Begin

Before you configure V.25 bis on the router, make sure you have the following:

- V.25 bis modems that support synchronous V.25 bis commands and the 1988 ITU/CCITT V.25 bis specification.
- If your modem does not automatically detect answer originate, you must:
  - Configure the modem at one end of the link to originate calls.
  - Configure the modem at the other end of the link to answer calls.
  - Set up the modem on the answering end to auto-answer.

---

### Configuration Procedures

This section describes how to configure your router for V.25 bis. The tasks you need to perform are:

1. Adding V.25 bis addresses
2. Configuring V.25 bis parameters
3. Adding dial circuits
4. Configuring dial circuits

**Note:** You must restart the router for changes to the V.25 bis configuration to take effect.

### Adding V.25 bis Addresses

You need to add a V.25 bis address for each local V.25 bis interface as well as for each destination. The V.25 bis address includes:

- *Address Name*. The address name is a description of the address. You can use any string of up to 23 printable ASCII characters.
- *Network Dial Address*. Telephone number of the local or destination port. You can enter up to 30 characters that are in the valid format of the connected V.25 bis modem. For additional information consult your modem manual.

**Note:** The valid character set for telephone numbers as defined by the CCITT and supported by the IBM 2216 includes:

- The decimal digits 0 through 9
- Colon (:) — “Wait Tone”

## Using V.25bis

- Left-angled bracket (<) —“Pause”, used for inserting a fixed delay (dependent on modem) between digit sequences. For example, when going through a PBX or PTN.
- Equal (=) — “Separator 3”, which is “for national use.” (Consult your modem manual.)
- The letter P — “Dialing to be continued in Pulse mode.” (Not supported by some modems.)
- The letter T — “Dialing to be continued in DTMF mode.” (Not supported by some modems.)

To add a V.25 bis address, enter the **add v25-bis-address** command at the Config> prompt. For example:

```
Config>add v25-bis-address
Assign address name [1-23] chars []? remote-site-baltimore
Assign network dial address [1-30 digits] []? 19095551234
```

## Configuring the V.25 bis Interface

This section explains how to configure the V.25 bis interface. To configure, do the following:

1. To set up a serial line interface for V.25 bis, set the data-link protocol for the serial line interface. From the Config> prompt, use the **set data-link v25bis** command. For example:

```
Config>set data-link v25bis
Interface Number [0]? 2
```

2. Display the V.25bis Config> prompt by entering the **network** command followed by the number of the interface. For example:

```
Config>network 2
V.25bis Data Link Configuration
V25bis Config>
```

You can use the **list devices** command at the Config> prompt to display a list of interface numbers configured on the router.

3. Use the **set local-address** command to specify the network address name of the local port. You must enter one of the address names you defined using the **add v25bis-address** command. For example:

```
V25bis Config>set local-address
Local network address name []? remote-site-baltimore
```

**Note:** You must restart the router for configuration changes to take effect.

### Optional V.25 bis Parameters

The following are optional V.25 bis parameters you can set. For a complete description of these commands, see “V.25 bis Configuration Commands” on page 705.

- You can limit the number of successive calls to an address that is inaccessible or that refuses those calls. To do so, use the **set retries-no-answer** and the **set timeout-no-answer** commands.
- The **set disconnect-timeout** command controls the amount of time the router waits to initiate a call after dropping a signal from the previous call.
- The **set command-delay-timeout** command specifies the amount of time the router waits to initiate or answer a call after it turns on DTR.
- The **set connect-timeout** command specifies the number of seconds allowed for a call to be established.
- The **set duplex** command specifies the duplexing mode for the call.

- The **set encoding** command sets the encoding for the call.
- When you have finished configuring the interface, you can use the **list** command to display your configuration.

## Adding Dial Circuits

Dial circuits are mapped to V.25 bis serial line interfaces. You can map multiple dial circuits to one serial line interface.

To add a dial circuit, use the **add device dial-circuit** command from the `Config>` prompt. The software assigns an interface number to each circuit. You will use this number to configure the dial circuit.

### Example:

```
Config>add device dial-circuit
Adding device as interface 6
```

**Note:** Dial circuits default to the Point-to-Point protocol (PPP). You can also set the dial circuit to use Frame Relay (FR) or SDLC.

## Configuring Dial Circuits

This section describes how to configure a dial circuit. For a complete description of the dial circuit commands, see “Chapter 54. Configuring and Monitoring Dial Circuits” on page 745.

**Note:** If the encapsulator type is SDLC, the only dial circuit parameter that you can set is the base net number.

To configure the dial circuit, do the following:

1. Display the `Circuit Config>` prompt by entering the **network** command followed by the interface number of the dial circuit. You can use the **list devices** command at the `Config>` prompt to display a list of the dial circuits that you added. For example:

```
Config>network 6
Circuit configuration
Circuit Config>
```

2. Map the dial circuit to a V.25 bis interface. The Base net is the V.25 bis interface number. For example:

```
Circuit Config>set net
Base net for this circuit [0]? 0
```

3. Specify the address name of the remote router to which the dial circuit will connect. You must use one of the names you defined using the **add v25-bis-address** command. For example:

```
Circuit Config>set destination
Assign destination address name []? newyork
```

4. Configure the dial circuit to initiate outbound calls only, accept inbound calls only, or both initiate and accept calls.

Use the **set calls** command. To avoid a conflict if both ends of the link attempt to establish a call at the same time, configure the dial circuit at one end of the link to accept inbound calls only, and configure the dial circuit at the other end of the link to initiate outbound calls only. For example:

```
Circuit Config>set calls outbound
Circuit Config>set calls inbound
```

**Note:** For WAN Restoral operations or another dial-on-demand application, you should set up the circuit for either inbound or outbound calls.

5. Specify the timeout period for the circuit.

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Use the **set idle** command. If there is no traffic over the circuit for this specified time period, the dial circuit hangs up. To configure the circuit as a dedicated circuit, set the idle timer to zero. To configure the circuit to dial on demand, set the idle timer to a value other than zero. The range is 0 to 65535 and the default is 60 seconds. For example:

```
Circuit Config>set idle
Idle timer (seconds, 0 means always active) [60]? 0
```

**Note:** For WAN Restoral or WAN Reroute operations you must set the idle time to 0.

6. Optionally, you can delay the time between when a call is established and the initial packet is sent.

Use the **set selftest-delay** command. Setting a selftest delay can prevent initial packets from being dropped. If your modems take extra time to synchronize, adjust this delay. For example:

```
Circuit Config>set selftest-delay
Selftest delay(milli-seconds,0 means no delay)[150]?200
```

7. Set the inbound address name.

Use the **set inbound** command. You need to use this command only if you set up the circuit for both inbound and outbound calls and if the router's destination address is different from the destination address that the remote router dials. For example, the numbers would be different if one of the routers must go through a PBX, international, or inter-LATA exchange. For example:

```
Circuit Config>set inbound
Assign destination inbound address name []? newyork
```

The inbound address name must match one of the names that you defined using the **add v25-bis-address** command.

8. Set the duplexing mode for the circuit using the **set duplex** command.
9. Set the encoding mode for the circuit using the **set encoding** command.
10. Optionally, you can enter the configuration process for the data-link layer protocol that is running on the dial circuit (PPP or Frame Relay). Use the **encapsulator** command. For example:

```
Circuit Config>encapsulator
```

---

## Chapter 51. Configuring and Monitoring the V.25 bis Network Interface

This chapter describes the V.25 bis configuration and operational commands and GWCON commands. It includes the following sections:

- “Accessing the Interface Configuration Process”
- “V.25 bis Configuration Commands”
- “Accessing the Interface Monitoring Process” on page 709
- “V.25 bis Monitoring Commands” on page 709
- “V.25 bis and the GWCON Commands” on page 714

---

### Accessing the Interface Configuration Process

Use the following procedure to access the V.25 bis configuration process.

1. At the OPCON prompt, enter the **talk** command and the PID for CONFIG. (For more detail on this command, refer to What is the OPCON Process?.) For example:

```
* talk 6
Config>
```

After you enter the **talk 6** command, the CONFIG prompt (Config>) displays on the console. If the prompt does not appear when you first enter **CONFIG**, press **Return** again.

2. At the CONFIG prompt, enter the **list devices** command to display the network interface numbers for which the router is currently configured.
3. Record the interface numbers.
4. Enter the CONFIG **network** command and the number of the interface you want to configure. For example:

```
Config> network 1
V.25bis Config>
```

The V.25 bis configuration prompt now displays on the console.

---

### V.25 bis Configuration Commands

Table 97 summarizes and the rest of the section explains the V.25 bis configuration commands. These commands allow you to display, create, or modify a V.25 bis configuration. Enter the V.25 bis configuration commands at the V.25bis Config> prompt.

Table 97. V.25 bis Configuration Commands Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
List	Displays the V.25 bis configuration.
Set	Sets the local address, connect, disconnect, and no answer timeouts, number of retries after no answer, the duplexing mode, command delay timeout, and encoding.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## V.25 bis Configuration Commands

### List

Use the **list** command to display the current V.25 bis configuration.

#### Syntax:

**list**

-

#### Example:

```
list
      V.25bis Configuration

Duplex                = Full
Encoding              = NRZ
Local Network Address Name = v403
Local Network Address  = 15088982403

Non-Responding addresses:
Retries               = 1
Timeout              = 0 seconds

Call timeouts:
Command Delay         = 0 ms
Connect              = 60 seconds
Disconnect            = 2 seconds

Cable type            = V.35 DTE
Speed                 = 9600
```

#### Duplex

Displays the duplex mode for the interface once the dial connection has been established.

#### Encoding

Displays the transmission encoding scheme for the interface once the dial connection has been established. Encoding is either NRZ (non-return to zero) or NRZI (non-return to zero inverted).

#### Local Network Address Name:

Displays the network address name of the local port.

#### Local Network Address:

Displays the network dial address of the local port.

#### Non-responding addresses:

##### Retries

Maximum number of calls the router attempts to make to a non-responding address during the timeout period.

##### Timeout

If the router reaches the maximum number of retries to a non-responding address, it does not attempt to establish the call until this time has expired. This timeout period begins when the router attempts the first call.

#### Call timeouts:

Number of call timeouts.

##### Command Delay

Amount of time, in milliseconds, that the router waits to initiate or answer a call after it turns on DTR (Data Terminal Ready). If you set this parameter to 0, the router waits for the modem to respond to DTR with the CTS (Clear to Send) signal before it issues commands.



**Connect**

Number of seconds allowed for a call to be established. If this parameter is set to 0, the modem controls the connection establishment timeout.

**Disconnect**

After the routers drops DTR it waits this amount of time before it initiates further calls. If you set this parameter to 0, the router waits for the modem to respond to the DTR drop by dropping CTS and DSR before it initiates the next call.

**Set**

Use the **set** command to configure local addresses, timeouts and delays for calls, retries and timeouts for non-responding addresses, and the HDLC cable type.

**Syntax:**

```

set          command-delay timeout . . .
             connect-timeout . . .
             disconnect-timeout . . .
             duplex
             hdlc cable . . .
             hdlc encoding . . .
             hdlc speed . . .
             local-address . . .
             retries-no-answer . . .
             timeout-no-answer . . .

```

**command-delay-timeout** # of milliseconds

After the router turns on DTR (Data Terminal Ready), it waits this amount of time before it initiates or answers a call. If you set this parameter to 0, the router waits for the modem to respond to DTR with the CTS (Clear to Send) signal before it issues commands. The range is 0 to 65535 milliseconds, and the default is 0.

**connect-timeout** # of seconds

Sets the number of seconds allowed for a call to be established. The range is 0 to 65535 seconds, and the default is 60. If you set this parameter to 0, the modem controls the connection timeout. You should initially set this parameter to 0 and then use ELS event V25B.027 to find out how long it takes to establish connections to various destinations. You can then set this parameter to a number slightly higher than the longest connect time.

**Note:** Normally government regulation limits modem manufacturers to a maximum length for call setup. This value is merely an optimization, although inter-operation with some DSUs may require that you change this parameter.

**disconnect-timeout** # of seconds

Specifies the amount of time, in seconds, that the router waits after dropping DTR before it initiates further calls. The range is 0 to 65535

## V.25 bis Configuration Commands

seconds, and the default is 2. If you set this parameter to 0, the router waits for the modem to respond to the DTR drop by dropping CTS and DSR before it initiates the next call.

### **duplex**

Specifies the duplex type of the line.

When full-duplex is configured, the RTS modem signal remains asserted once the dial connection has been established.

When half-duplex is configured, the router raises RTS when it is time to transmit and waits for CTS to be asserted by the modem. After CTS is asserted, the router transmits data packets and then drops RTS when the router is through transmitting to let the peer device respond.

Only configure half-duplex when using the V.25 bis interface to handle switched SDLC and the attached modem requires the half-duplex mode of operation.

#### **Notes:**

1. Duplex must be full for PPP or Frame Relay circuits.
2. If you configure half-duplex for a V.25 bis interface on the 8-port EIA-232E adapter, you must configure the line speed using the **set hdlc speed** command.

**Valid values:** full or half

**Default value:** full

### **hdlc cable** *rs232 dte*

Specifies the type of cable connected to this interface. Setting this parameter allows you to view the cable type when you enter the **interface** command at the GWCON (+) prompt and when you enter the **statistics** command at the V.25bis> monitoring prompt. This parameter does not affect operation of the router.

### **hdlc encoding**

Sets the HDLC transmission encoding scheme as NRZ (non-return to zero) or NRZI (non-return to zero inverted). Most configurations use NRZ. The configured encoding is used for the end-to-end connection.

**Note:** Although you might configure NRZI, the exchange between the DTE and the modem (as described by CCITT recommendation, *V.25 bis*) uses NRZ as the encoding scheme.

**Valid values:** NRZ or NRZI

**Default value:** NRZ

### **hdlc speed**

Specifies the line speed for this interface. Setting this parameter allows you to view the line speed when you enter the interface command at the GWCON (+) prompt and when you enter the statistics command at the V.25bis> monitoring prompt. The range is 2400 to 64 000 bps. The default is 9600 bps.

**Note:** This command does not affect the actual line speed but it sets the speed some protocols, such as IPX, use when calculating routing cost parameters for dial circuits mapped to the V.25 bis interface.

### **local-address** *address name*

Specifies the network address name of the local port. This address name must match one of the names that you defined at the Config> using the **add v25-bis-address** command.

**Example:** `set local-address line-1-local`

### **retries-no-answer** *value*

Some telephone service providers impose restrictions on automatic recalling devices to limit the number of successive calls to an address that is inaccessible or that refuses those calls. This parameter specifies the maximum number of calls the router attempts to make to a non-responding address during the timeout period. The range is 0 to 10, and the default is 1.

**Note:** Government regulation may also impose limits on the modem manufacturer that would supersede this parameter.

### **timeout-no-answer** *# of seconds*

After the router reaches the maximum number of **retries-no-answer** to a non-responding address, it does not initiate further calls to that address until this time has expired. This timeout period begins when the router attempts the first call to an address. The range is 0 to 65535 seconds, and the default is 0. If you set this parameter to 0, the modem controls the timeout period.

---

## Accessing the Interface Monitoring Process

To access the interface monitoring process for V.25 bis, enter the following command at the GWCON (+) prompt:

```
+ network #
```

Where # is the number of the V.25 bis serial line. You cannot directly access the V.25 bis monitoring process for dial circuits, but you can monitor the dial circuits that are mapped to the serial line interface.

**Note:** V.25 bis interfaces also have ELS troubleshooting messages that you can use to monitor V.25 bis-related activity. See the *IBM Nways Event Logging System Messages Guide* for further details.

---

## V.25 bis Monitoring Commands

This section summarizes and explains the V.25 bis operating commands. These commands allow you to view the calls, circuits, parameters, and statistics of the V.25 bis interfaces.

Enter the V.25 bis monitoring commands at the V.25bis> prompt. Table 98 shows the commands.

*Table 98. V.25 bis Monitoring Command Summary*

Monitoring Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Calls	List the number of completed and attempted connections made for each dial circuit mapped to this interface since the last time statistics were reset on the router.

## V.25 bis Operating Commands

Table 98. V.25 bis Monitoring Command Summary (continued)

Monitoring Command	Function
Circuits	Shows the status of all data circuits configured on the V.25 bis interface.
Parameters	Displays the current parameters for the V.25 bis interface. (This command is similar to the V.25bis Config> list command.)
Statistics	Displays the current statistics for the V.25 bis interface.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

## Calls

Use the **calls** command to list the number of completed and attempted connections made for each dial circuit mapped to this interface since the last time statistics were reset on the router.

### Syntax:

#### calls

### Example:

```
calls
Net Interface Site Name      In   Out  Rfsd  Blckd
1   PPP/0     v403      2    0    0     0
```

Unmapped connection indications: 0

**Net** Number of the dial circuit mapped to this interface.

### Interface

Type of interface and its instance number.

### Site Name

Network address name of the dial circuit.

**In** Number of inbound connections accepted for this dial circuit.

**Out** Number of completed connections initiated by this dial circuit.

**Rfsd** Number of connections initiated by this dial circuit that were refused by the network or the remote destination port.

**Blckd** Number of connection attempts that the router blocked. The router blocks connection attempts if the local port is already in use, the maximum number of retries to a non-responding address is reached, or a modem is not responding.

### Unmapped connection indications:

Number of connection attempts that were refused by the router because there were no enabled dial circuits that were configured to accept the incoming calls.

## Circuits

The **circuits** command shows the status of all dial circuits configured on the V.25 bis port.

### Syntax:

#### circuits

### Example:

```

circuit
Net Interface  MAC/Data-Link  State  Reason  Duration
2  PPP/0      Point to Point  Avail  Rmt Disc  1:02:25

```

**Net** Number of the dial circuit mapped to this interface

### Interface

Type of interface and its instance number.

### MAC/DataLink

Type of datalink protocol configured for this dial circuit.

**State** Current state of the dial circuit:

Up - currently connected

Available - not currently connected, but is available

Disabled - dial circuit was disabled

Down - failed to connect because of a busy dial circuit or because the link-layer protocol is down

### Reason

Reason for the current state:

nnn\_Data - (where nnn is the name of a protocol) the circuit is Up because a protocol had data to send.

Remote Disconnect - the circuit is either Down or Available because the remote destination disconnected the call.

Operator Request - the circuit is Available because the last call was disconnected by a monitoring command.

Inbound - the circuit is Up because the circuit answered an inbound call.

Restoral - the circuit is Up because of a WAN Restoral operation.

Self Test - the circuit was configured as static (idle time=0) and successfully connected once it was enabled.

### Duration

Length of time that the circuit has been in the current state.

## Parameters

Use the **parameters** command to display the current V.25 bis serial line configuration. Note that this is the same information displayed in the V.25bis Config> list command.

### Syntax:

**parameters**

### Example:

```

parameters
      V.25bis port Parameters

Local Network Address Name  = v402
Local Network Address      = 15088982402

Non-Responding addresses:
Retries                    = 1
Timeout                    = 0 seconds

Call timeouts:
Command Delay              = 0 ms
Connect                    = 0 seconds
Disconnect                  = 0 seconds

```

### Local Network Address Name:

Network address name of the local port.

## V.25 bis Operating Commands

### Local Network Address:

Network dial address of the local port.

### Non-responding addresses:

#### Retries

Maximum number of calls the router attempts to make to a non-responding address during the timeout period.

#### Timeout

If the router reaches the maximum number of retries to a non-responding address, it does not attempt to establish the call until this time has expired. This timeout period begins when the router attempts the first call to an address.

### Call timeouts:

#### Command Delay

Amount of time, in milliseconds, that the router waits to initiate or answer a call after it turns on DTR (Data Terminal Ready). If you set this parameter to 0, the router waits for the modem to respond to DTR with the CTS (Clear to Send) signal before it issues commands.

#### Connect

Number of seconds allowed for a call to be established. If this parameter is set to 0, the modem controls the connection establishment timeout.

#### Disconnect

After the routers drops DTR it waits this amount of time before it initiates further calls. If you set this parameter to 0, the router waits for the modem to respond to the DTR drop by dropping CTS and DSR before it initiates the next call.

## Statistics

Use the **statistics** command to display the current statistics for this V.25 bis interface.

### Syntax:

**statistics**

### Example:

```
statistics
V.25bis port Statistics
```

```
Adapter cable:          RS-232 DTE
```

```
Nicknames:  RTS CTS DSR DTR DCD RI
RS-232      CA CB  CC  CD  CF  CE
State:      OFF OFF OFF OFF OFF OFF
```

```
Line speed:           4800
Last port reset:     24 seconds ago
```

```
Input frame errors:
CRC error              0  alignment (byte length)  0
missed frame          0  too long (> 2182 bytes)  0
aborted frame         0  DMA/FIFO overrun          0
```

## V.25 bis Operating Commands

L & F bits not set	0		
Output frame counters:			
DMA/FIFO underrun errors	0	Output aborts sent	0

### **Adapter cable:**

Type of adapter cable being used.

### **Nicknames:**

Common names for the circuits.

### **RS-232**

EIA 232 (also known as RS-232) names for the circuits.

**State:** Current state of the circuits: ON, OFF, or "---," which means that the state is undefined for this type of interface.

### **Line speed:**

The transmit clock speed (approximate).

### **Last port reset:**

Length of time since the port was reset.

### **Input frame errors:**

#### **CRC error**

Number of packets received that contained checksum errors and as a result were discarded.

#### **Alignment (byte length)**

Number of packets received that were not an even multiple of 8 bits in length and as a result were discarded.

#### **Missed Frame**

When a frame arrives at the device and there is no buffer available, the hardware drops the frame and increments the missed frame counter.

#### **too long (> nnnn bytes)**

Number of packets received that were greater than the configured frame size (nnnn) and as a result were discarded.

#### **aborted frame**

Number of packets received that were aborted by the sender or a line error.

#### **DMA/FIFO overrun**

The number of times the serial interface card could not send data fast enough to the system packet buffer memory to receive packets from the network.

#### **L & F bits not set**

On serial interfaces, the hardware sets input-descriptor information for arriving frames. If the buffer can accept the complete frame upon arrival, the hardware sets both the last and first bits of the frame, indicating that the buffer accepted the complete frame. If either of the bits is not set, the packet is dropped, the L & F bits not set counter is incremented, and the buffer is cleared for reuse.

**Note:** It is unlikely that the L & F bits not set counter will be affected by traffic.

### **Output frame counters:**

## V.25 bis Operating Commands

### DMA/FIFO underrun errors

Number of times the serial interface card could not retrieve data fast enough from the system packet buffer memory to transmit packets onto the network.

### Output aborts sent

Number of transmissions that were aborted as requested by upper-level software.

---

## V.25 bis and the GWCON Commands

While V.25 bis has its own monitoring process for monitoring purposes, the router also displays configuration information and complete statistics for devices and circuits when you use the interface, statistics, and error commands from the GWCON environment. You can also use the GWCON **test** command to test DCEs and circuits.

**Note:** Issuing the **test** command to the V.25 bis serial interface causes the current call to be dropped and re-dialed.

For more information on the GWCON command, see “Chapter 8. The Operating/Monitoring Process (GWCON - Talk 5) and Commands” on page 109.

## Statistics for V.25 bis Interfaces and Dial Circuits

Use the **interface** command at the GWCON (+) prompt to display statistics for V.25 bis serial line interfaces and dial circuits.

To display the following statistics for a V.25 bis serial line interface, use the **interface** command followed by the *interface number* of the V.25 bis serial line interface.

**Example:** interface 10

```

Nt Nt' Interface Slot-Port Self-Test Passed Self-Test Failed Maintenance Failed
10 10 V.25/0 Slot: 4 Port: 0 1 0 0
V.25bis Base Net MAC/data-link on EIA 232E/V.24 interface
Adapter cable: RS-232 DTE
V.24 circuit: 105 106 107 108 109 125
Nicknames: RTS CTS DSR DTR DCD RI
RS-232: CA CB CC CD CF CE
State: OFF OFF OFF ON OFF OFF
Line speed: 19.200 Kbps
Last port reset: 55 minutes, 1 second ago
Input frame errors:
CRC error 6 alignment (byte length) 0
missed frame 1 too long (> 2054 bytes) 0
aborted frame 34 DMA/FIFO overrun 0
Output frame counters:
DMA/FIFO underrun errors 0 Output aborts sent 0
```

To display the following statistics for a dial circuit, use the **interface** command followed by the *interface number* of the dial circuit.

**Example:**



## V.25 bis Operating Commands

### interface 29

Nt	Nt'	Interface	Self-Test Passed	Self-Test Failed	Maintenance Failed
29	10	PPP/20	2	1	0

Point to Point MAC/data-link on V.25bis Dial Circuit interface

The following list describes the output for both serial line interfaces and dial circuits.

**Nt** Serial line interface number or dial circuit interface number.

**Nt'** If "Nt" is a dial circuit, this is the interface number of the V.25 bis serial line interface to which the dial circuit is mapped.

### Interface

Interface type and its instance number.

**Slot** The slot number of the interface running V.25 bis.

**Port** The port number of the interface that is running V.25 bis.

### Self-Test Passed

Number of self-tests that succeeded.

### Self-Test Failed

Number of self-tests that failed.

### Maintenance: Failed

Number of maintenance failures.

### Adapter cable:

Type of adapter cable that is being used.

### V.24 circuit:

Circuit numbers as identified by V.24 specifications.

### RS-232

EIA 232 (also known as RS-232) names for the circuits.

**State** Current state of the circuits (ON or OFF).

### Line speed

The transmit clock speed (approximate).

### Last port reset

Length of time since the port was reset.

### Input frame errors:

#### CRC error

Number of packets received that contained checksum errors and as a result were discarded.

#### Alignment (byte length)

Number of packets received that were not an even multiple of 8 bits in length and as a result were discarded.

#### Missed Frame

When a frame arrives at the device and there is no buffer available, the hardware drops the frame and increments the missed frame counter.

#### too long (> nnnn bytes)

Number of packets received that were greater than the configured frame size and as a result were discarded.

## V.25 bis Operating Commands

### **DMA/FIFO overrun**

The number of times the serial interface card could not send data fast enough to the system packet buffer memory to receive packets from the network.

### **L & F bits not set**

On serial interfaces, the hardware sets input-descriptor information for arriving frames. If the buffer can accept the complete frame upon arrival, the hardware sets both the last and first bits of the frame, indicating that the buffer accepted the complete frame. If either of the bits is not set, the packet is dropped, the L & F bits not set counter is incremented, and the buffer is cleared for reuse.

**Note:** It is unlikely that the L & F bits not set counter will be affected by traffic.

### **aborted frame**

Number of packets received that were aborted by the sender or a line error.

### ***Output frame counters:***

#### **DMA/FIFO underrun errors**

Number of times the serial interface card could not retrieve data fast enough from the system packet buffer memory to transmit packets onto the network.

#### **Output aborts sent**

Number of transmissions that were aborted as requested by upper-level software.

---

## Chapter 52. Using the ISDN Interface

### Important

The original 2216 ISDN T1 and E1 Single Port LICs (IBM PN 11J7466 or 78H6147 and 11J7465 or 78H6148 respectively), do not support MAC address assignment for DIALs clients. This assignment is only necessary for customers who want to use the NetBIOS and/or SNA protocols natively in the DIALs Remote LAN Access environment. All other ISDN functions and DIALs functions (for example, Dial-in IP and IPX) will work correctly without an upgrade. The newer ISDN T1 and E1 Single Port LICs support MAC address assignment for DIALs clients and all DIALs functions. Customers with the original ISDN LICs who want to use NetBIOS and/or SNA DIALs functions should contact their IBM service representative to upgrade to the newer LICs.

This chapter describes the Integrated Services Digital Network (ISDN) interfaces on the IBM 2216. It includes the following sections:

- “ISDN Overview”
- “ISDN Cause Codes” on page 720
- “Sample ISDN Configurations” on page 722
- “Channelized T1/E1” on page 723
- “Requirements and Restrictions for ISDN Interfaces” on page 723
- “Before You Begin” on page 724
- “Configuration Procedures” on page 724.
- “I.431 Switch Variant” on page 728

---

### ISDN Overview

The ISDN interface software allows you to establish ISDN connections between routers or from a dial-in user to a router. You can set up the interface to act as a dedicated link or to initiate and accept switched-circuit connections, either on demand, automatically from restart, or on command by the operator.

I.430, I.431, and Channelized T1/E1 are not switched. They are permanent leased-line type connections.

### ISDN Adapters and Interfaces

The IBM 2216 supports the following ISDN-PRI adapters:

- 1-Port E1 ISDN-PRI
- 1-Port T1/J1 ISDN-PRI
- 4-Port E1 ISDN-PRI
- 4-Port T1/J1 ISDN-PRI
- 8-Port E1 ISDN-PRI
- 8-Port T1/J1 ISDN-PRI

The PRI/Channelized adapters have an integrated CSU/DSU, so an external CSU/DSU is not required.

**Note:** If you are upgrading from BRI to PRI from talk 6, you must clear the ISDN and dial configurations first, then bring up PRI and configure for PRI.

- The PRI adapter does not support multipoint.

## Using ISDN

- The PRI adapter provides T1/J1 and E1 support.
  - T1/J1 supports twenty-three 64-kbps B-channels and one 64-kbps D-channel.
  - E1 supports thirty 64-kbps B-channels and one 64-kbps D-channel.
- The PRI adapter provides enhanced line ID (LID) support.

## Dial Circuits

There are four types of dial circuits:

- Static circuits (or link)

### Notes:

1. I.430, I.431, and Channelized T1/E1 are leased line connections and therefore do not dial.
  2. ISDN considers X.25 traffic over the D-channel as a static circuit. However, you could configure the X.25 circuit as a PVC or SVC using the **encapsulator** command under the dial circuit configuration.
- Switched circuits that dial on demand and hang up after a specified idle time
  - WAN restoral circuits that are used only when an assigned primary leased line fails
  - Dial-in circuits are used to provide remote clients access to resources on the network.

When bridging over a dial on demand interface it is recommended that you disable spanning tree for that interface and create MAC filters to filter out all undesired traffic. (The MAC filters would drop all frames that are not destined specific MAC addresses.) This keeps the dial circuit from staying connected due to unwanted traffic.

**Note:** You don't need to add any MAC filters when running BAN traffic on a FR dial-on-demand interface. The BAN software always performs filtering such that the only bridging traffic that will keep a dial-on-demand circuit from hanging up is traffic whose destination MAC address matches the BAN DLCI MAC address.

Add a dial circuit for each potential destination. You can map multiple dial circuits to one ISDN interface. Each dial circuit is a normal serial line network, running Point-to-Point Protocol (PPP), Frame Relay or X.25 (for D-channels only). These protocols are configured to operate over the dial circuits.

**Note:** You can assign a destination name to a **connection list** (add ISDN address) and assign a destination number to each line in the list. When that destination name is called, the numbers in the list are tried one by one until a connection is made or the list is exhausted.

Routable protocols and bridging and routing features cannot communicate directly with an ISDN interface. You need to configure these protocols to run on the dial circuits. This implementation supports the following protocols and features for ISDN dial circuits:

- APPN
- Banyan VINES
- DECnet
- DLSw
- IP
- IPX
- IPv6
- AppleTalk 2

- Bridging (SRB, STP, SR-TB, and SRT)
- Bandwidth reservation
- WAN restoral
- DIALS

## Addressing

To place an ISDN call, specify the telephone number of the destination. To identify yourself to the switch, you need to specify your own telephone number. For ISDN, telephone numbers are called network dial addresses and, for convenience, they are given names called network address names that represent the telephone number.

When you set up an ISDN interface, you add addresses for each potential destination as well as for your own telephone number, which is called the local network address. When you configure a dial circuit, the local network address is obtained from the physical interface configuration and you set a destination address for the circuit.

## Oversubscribing and Circuit Contention

An ISDN PRI T1/J1 interface can support a maximum of 23 active calls, and an ISDN PRI E1 interface can support a maximum of 30 active calls. There can be more dial circuits configured on an ISDN interface than active calls supported. This is called oversubscribing. If a dial circuit attempts a call when the ISDN interface has all calls active, there are two possibilities: 1) If the dial circuit has a higher priority than a dial circuit with an active call, the active call will be terminated for the low priority dial circuit and a call will be attempted for the higher priority dial circuit. 2) If the dial circuit does not have a higher priority than any dial circuits with active calls, no call will be made. The router will drop packets sent by protocols on dial circuits that cannot connect to their ISDN destination.

**Note:** There is no circuit contention when you are running X.25 over the D-channel because the D-channel is always available for the X.25 connection.

See “Set” on page 748 for more information about priority.

## Cost Control Over Demand Circuits

Dial-on-demand circuits always appear to be in the Up state to the protocols. Most protocols send out periodic routing information that could cause the router to dial out each time the routing information is sent over dial-on-demand circuits. To limit periodic routing updates, configure IP and OSI to use only static routes and disable the routing protocols (RIP, OSPF) over the dial circuits. If you are using IPX, configure static routes and services and disable the routing protocols (RIP, SAP) over the dial circuits. Another option is to configure low-frequency RIP and SAP update intervals, although this does not prevent RIP and SAP from broadcasting routing information changes as they occur. You should also enable IPX Keepalive filtering, which prevents keepalive and serialization packets from continually activating the dial-on-demand link.

## Caller ID and LIDS

If the ISDN service provides the ANI or CallerID (CLID) service by providing the Calling Party Number (CPN) in the ISDN setup message, you can use it to match up dial circuits to the appropriate caller. Otherwise, you must either use a proprietary line identification protocol (LID) or provide circuits that are “ANY INBOUND”.

## Using ISDN

The LID protocol uses the inbound destination in the dial circuit configuration and LID received to match the calling dial circuit to the receiving dial circuit. The LID protocol is a brief identification protocol initiated by the caller and answered by the receiver. If the caller does not provide the LID message, the receiver may reject the call, if any\_inbound dial circuit is not configured. LID exchanges occur on the B-channel.

When connecting to routes that do not support logical ids (LIDS), you can suppress the LID exchange using the config option under the individual dial circuit.

```
config> set lid_used no
```

On the incoming side, if lid\_used=no, the call is completed and the IBM 2216 does not wait for the LID to come on the B\_channel. Instead, the IBM 2216 tries to use the callerID received. If there is no match on the callerID the IBM 2216 checks to see if an any\_inbound dial circuit is available. If no any\_inbound circuit is available the call is rejected.

On the outgoing side, PPP/FR selftest starts immediately, after B-Channel is allocated.

---

## ISDN Cause Codes

This ISDN implementation specifies a cause code that will stop the router from attempting to establish a connection through an ISDN interface. If the application retries, the router again attempts to establish a connection through this interface and will succeed if the original problem has been corrected. If during the retry the router encounters the same cause code, the application will not attempt further connection processing through this interface.

Cause code interpretations:

1. If cause0 is not "0x5" ignore the cause code.
2. If cause0 is "0x5" look at cause1. If the high-order (most significant) bit of cause1 is 0N, set it to 0FF.
3. Convert the result to decimal and look up the meaning in the following table, which is taken from *ITU-T Recommendation Q.850*.

Table 99. ISDN Q.931 Cause Codes

Code	Cause
1	Unallocated (unassigned number)
2	No route to specified transit network
3	No route to destination
6	Channel unacceptable
7	Call awarded and is being delivered in an established channel
16	Normal call clearing
17	User busy
18	No user responding
19	No answer from user (user alerted)
21	Call rejected
22	Number changed
26	Non-selected user clearing
27	Destination out of order

Table 99. ISDN Q.931 Cause Codes (continued)

Code	Cause
28	Invalid number format (address incomplete)
29	Facility rejected
30	Response to STATUS ENQUIRY
31	Normal, unspecified
34	No circuit/channel available
38	Network out of order
41	Temporary Failure
42	Switching equipment congestion
43	Access information discarded
44	Requested circuit/channel not available
47	Resource unavailable, unspecified
49	Quality of Service not available
50	Requested facility not subscribed
57	Bearer capability not authorized
58	Bearer capability not presently available
63	Service or option not available, unspecified
65	Bearer capability not implemented
66	Channel type not implemented
69	Requested facility not implemented
70	Only restricted digital information bearer capability is available
79	Service or option not implemented, unspecified
81	Invalid call reference value
82	Identified channel does not exist
83	A suspended call exists, but this call identity does not
84	Call identity in use
85	No call suspended
86	Call having the requested call identity has been cleared
88	Incompatible destination
91	Invalid transit network selection
95	Invalid message, unspecified
96	Mandatory information element is missing
97	Message type nonexistent or not implemented
98	Message not compatible with call state or message type nonexistent or not implemented
99	Information element nonexistent or not implemented
100	Invalid information element contents
101	Message not compatible with call state
102	Recovery on timer expiry
111	Protocol error, unspecified
127	Interworking, unspecified

## Sample ISDN Configurations

The following topics show several typical ISDN configurations.

### Frame Relay over ISDN Configuration

Figure 50 shows how you can connect to a Frame Relay network through an ISDN network. In this configuration, you set the data link on your dial circuits to Frame Relay.

**Note:** Dial circuits default to point-to-point (PPP) protocol. To change the protocol to Frame Relay, enter **set data-link fr** at the Config> prompt. A connection will only be usable if the data link on both ends matches (for example, either FR to FR, or PPP to PPP).

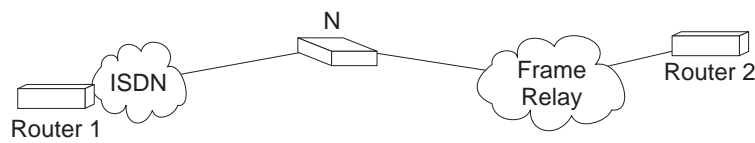


Figure 50. Frame Relay over ISDN Configuration

**Note:** N could be either an ISDN TA connected to the FR switch, or an ISDN card in a FR switch.

### WAN Restoral Configuration

Figure 51 shows how you can use an ISDN connection to back up a failed dedicated WAN link (WAN restoral). In this example, Router A normally uses the WAN link to communicate with Router B. If that connection fails, the ISDN dial-up link reconnects the two routers. When the WAN link recovers, the secondary link automatically disconnects. For more information on how to configure the router for WAN restoral, see Using WAN Restoral in *Using and Configuring Features*.

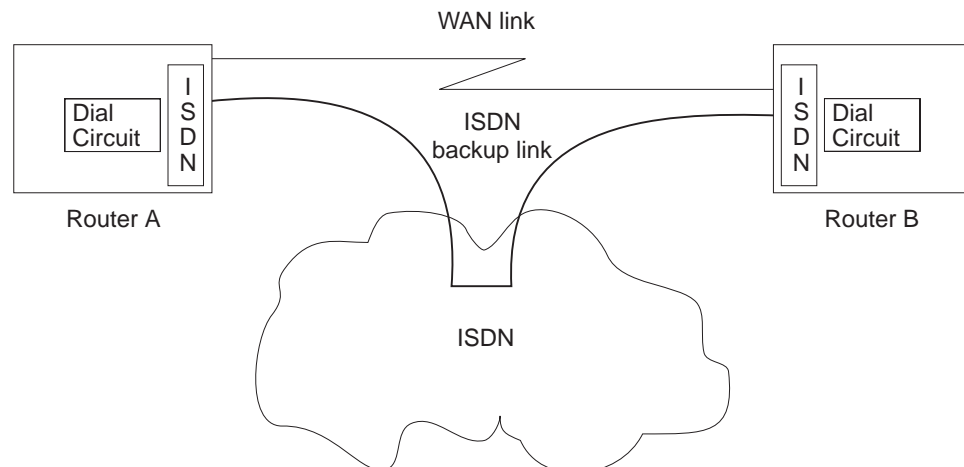


Figure 51. Using ISDN for WAN Restoral

For WAN Restoral, only dial circuits configured for PPP can be used as the secondary link. For WAN Reroute, either a PPP dial circuit or a FR dial circuit can be used as the alternate link.



---

## Channelized T1/E1

When configured for channelized, the Channelized/PRI adapter allows you to get Fractional/Channelized T1/J1/E1 support. You can have channels of 56-kbps or N\*64-kbps. This will let you multiplex multiple leased lines connections (for example: using V.35 at 56-kbps) into one physical connection.

To configure a T1 or E1 Primary adapter as channelized:

1. Select "Channelized" as the switch variant for the ISDN interface.
2. Configure the time slots to be used for this ISDN interface when you configure the dial circuit. See "Set" on page 748 for more information.

### Example of configuring a Channelized T1 interface:

```
Config>n 6
ISDN Config>set switch chan
ISDN Config>list

                ISDN Configuration

Maximum frame size in bytes      = 2048
Switch Variant/Service Type     = Channelized
Available Timeslots: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Config>n 7
Circuit config: 7>set net 6
Circuit config: 7>set timeslot 2 3 4 24
Circuit config: 7>list

Base net                = 6
Idle character          = 7E
Bandwidth               = 64 Kbps
Timeslot                = 2 3 4 24
```

**Note:** If this were an E1 circuit, the available timeslots would be 1 to 31.

---

## Requirements and Restrictions for ISDN Interfaces

### Switches/Services Supported

The ISDN Primary Rate Interface (PRI) supports the following switches/services:

Switch names	Valid command
AT&T 5ESS (North America)	5ESS
AT&T 4ESS (North America)	4ESS
Australia (AUSTEL)	AUSPRI
INS-Net 1500 (Japan, NTT)	INSPRI
National ISDN 2 (North America)	USNI2
NET 5 (Euro-ISDN, ETSI)	NET5
Northern Telecom DMS (DMSPRI)	DMSPRI
Native I.431	I431 (See "I.431 Switch Variant" on page 728.)
Channelized T1/E1	CHANNELIZED

### ISDN Interface Restrictions

- You cannot boot or dump the router over an ISDN interface.
- Except for BRI, which allows you to use the D-channel for X.25 packet data, you cannot use the D-channel for data traffic. Normally the D-channel is used only for setting up and taking down B-channel connections.

## Using ISDN

### Dial Circuit Configuration Requirements

You need to consider the following when you configure PPP or Frame Relay with ISDN:

- The ISDN interface will not enforce transmit delay counters that you set in the PPP configurations.
- Do not enable pseudo-serial-ethernet on the dial circuit.

---

### Before You Begin

Before you configure ISDN, you need the following information:

- Telephone number of the local ISDN port.
- Destination telephone numbers, including any telephone extensions.
- Type of switch to which the ISDN interface is connected. See “Switches/Services Supported” on page 723 for the list of switches.

**Note:** Additional parameters, such as TEI and SPID may be required based on your Switch Type and your service provider.

---

### Configuration Procedures

This section describes how to configure your ISDN interface and its associated dial circuits. Specifically, the tasks you need to perform are:

1. Adding ISDN addresses
2. Configuring ISDN parameters
3. Configuring the ISDN Interface
4. Adding dial circuits
5. Configuring dial circuits

**Note:** You must restart the router for configuration changes to take effect.

### Adding ISDN Addresses

You need to add an ISDN address for each ISDN interface as well as for each destination. The ISDN address includes:

- *Address Name.* The address name is a description of the address. You can use any string of up to 23 printable ASCII characters.
- *Network Dial Address.* Telephone number of the local or destination port. You can enter up to 25 numbers as well as 6 characters, including punctuation. The router uses only the numbers.
- *Network Subdial Address.* Optional. This is an additional part of telephone number, such as an extension, that is interpreted once the interface connects to a PBX. You can enter up to 20 numbers, as well as 11 additional spaces and punctuation. The router uses only the numbers.

To add an ISDN address, enter the **add isdn-address** command at the Config> prompt. For example:

```
Config>add isdn-address
Assign address name [23] chars []? baltimore
Assign network dial address [1-15 digits] []? 1-555-0983
Assign network subdial address [1-20 digits] []? 23
```

To see a list of your ISDN addresses, enter **list isdn-address** at the Config> prompt.

To delete an ISDN address from your list, enter the **delete isdn-address** command at the Config> prompt.

## Configuring ISDN Parameters

Access the ISDN Config> prompt. To access the ISDN Config> prompt, enter the **network** command followed by the interface number of the ISDN interface at the Config> prompt. For example:

```
Config>network 3
ISDN user configuration
ISDN Config>
```

You can use the **list devices** command at the Config> prompt to display a list of interface numbers configured on the router. See “ISDN Configuration Commands” on page 731 for more information about configuration commands.

1. Specify the type of switch/service to which this ISDN interface is connected. Use the **set switch-variant** command to specify the type of switch to which this ISDN interface is connected. See “Switches/Services Supported” on page 723 for the list of switches/services. For example:

```
ISDN Config>set switch net5
```

This is the software type running at the switch (for example, DMS100 means running DMS100 Custom software).

2. Specify the network address name of the local port. Use the **set local-address-name** command to specify the network address name of the local port. You must use one of the address names you defined using the **add isdn-address** command. For example:

```
ISDN Config>: set local-address-name
Assign local address name []? baltimore
```

**Note:** This is what we will send in the Calling Party Number field of the ISDN Setup message.

3. Set the directory number of the local port.
4. To set the frame size, use the **set framesize** command. For example:

```
ISDN Config>set framesize
Framesize in bytes (1024/2048/4096/8192) [1024]? 2048
```

**Note:** If you choose a frame size of 1024, PPP will not work over the ISDN dial circuit, since the minimum frame size for PPP is 1500.

For more information about setting the ISDN framesize, see “Set” on page 732.

### Optional ISDN Parameters

This section describes optional ISDN parameters you can set. For a complete description of these commands see “ISDN Configuration Commands” on page 731.

- For all ISDN switches except INSPRI, you can configure the limit for the number of calls to an address. Use the **set retries-call-address** command to set the number of calls to a non-responding destination. Use the **set timeout-call-address** command to set the time period to wait before trying the call again.

When you have finished configuring the ISDN interface, you can use the **list** command to display your configuration.

## Using ISDN

### Configuring the ISDN Interface

For the ISDN PRI, you need to configure T1/J1 or E1 for each adapter, depending upon the adapter.

#### T1/J1 PRI Interface

Specify the following T1/J1 parameters:

1. For the T1/J1 PRI interface, line build out specifies the attenuation of the signal transmitted by the router's T1 port. Specify the lbo (line build out) based on the information provided by the service provider.
  - a= -00.0 dB
  - b= -07.5 dB
  - c= -15.0 dB
  - d= -22.5 dB

For example:

```
set int lbo a
```

2. Specify the code, either B8ZS or AMI. B8ZS is default. The service provider provides this information.

For example:

```
set int code AMI
```

3. Specify ZBTISI- Zero Byte Time Slot Inversion, either ENABLED or DISABLED. The default is DISABLED. The service provider provides this information.

For example:

```
set int ZBTISI enabled
```

4. Specify the esf-data-link. Select one of the following based on the service subscription:

#### **ANSI-T1.403 ANSI-IDLE AT&T-IDLE**

Default is ANSI-T1.403

For example:

```
set int esf-data-link ansi-idle
```

#### E1 PRI Interface

For the E1 PRI interface, specify the following parameters:

1. Specify the code, either HDB3 or AMI. HDB3 is default. The service provider provides this information.

For example:

```
set int code HDB3
```

2. Specify the crc4, either ENABLED or DISABLED. Default is ENABLED. The service provider provides this information.

For example:

```
set int crc4 enabled
```

### Adding Dial Circuits

Dial circuits are mapped to ISDN interfaces. You can map multiple dial circuits to one ISDN interface.

To add a dial circuit, enter the **add device dial-circuit** command at the Config> prompt. The software assigns an interface number to each circuit. You will use this number to configure the dial circuit. For example:

```
Config>add device dial-circuit
Enter the number of PPP Dial Circuit interfaces [1]?
Adding device as interface 6
Base net for the circuits(s) [0]?
```

The number of dial circuits that can be configured depends on the total number of parameters to be configured and the size of the resulting configuration file.

**Note:** Dial circuits default to point-to-point (PPP) protocol. To change the dial circuit protocol to Frame Relay, enter the **set data-link fr** command at the Config> prompt. . Other data-link types (X.25, SDLC, and SRLY) are not supported over ISDN.

## Configuring Dial Circuits

This section describes how to configure a dial circuit.

1. Display the Circuit Config> prompt by entering the **network** command followed by the interface number of the dial circuit. You can enter the **list devices** command at the Config> prompt to display a list of the interface numbers configured on the router. For example:

```
Config> network 6
Circuit configuration
Circuit Config>
```

2. Map the dial circuit to an ISDN interface. Use the **set net** command. The Base net is the ISDN interface number. (This is needed only if you are changing the base net.) For example:

```
Circuit Config> set net
Base net for this circuit [0]? 3
```

**Note:** If the dial circuit data link type is X.25 or the base net switch variant is 1.43x or channelized, the following steps (3-11 on page 728) do not apply.

3. Specify the address name of the remote router to which the dial circuit will connect. You must use one of the names you defined using the **add isdn-address** command. For example:

```
Circuit Config> set destination
Assign destination address name []? baltimore
```

4. Configure the dial circuit to initiate outbound calls only, accept inbound calls only, or to both initiate and accept calls.

Use the **set calls** command. For example:

```
Circuit Config> set calls outbound
Circuit Config> set calls inbound
Circuit Config> set calls both
```

**Note:**

5. Specify the timeout period for the circuit.
 

Use the **set idle** command. If there is no traffic over the circuit for this specified time period, the dial circuit hangs up. To configure the circuit as a dedicated circuit, set the idle timer to zero. To configure the circuit to dial on demand, set the idle timer to a value other than zero. The range is 0 to 65535 and the default is 60 seconds. For example:

```
Circuit Config> set idle
Idle timer (seconds, 0 means always active) [0]? 0
```

**Note:** WAN restoral/reroute must be fixed.

6. Optionally, you can provide a LID name to send (instead of the default LID, which is the destination name) by specifying a lid\_out\_addr.

## Using ISDN

When more than one circuit is configured between two routers (parallel circuits), there must be a way to know which dial circuit connects them. For this purpose, a `lid_out_addr` is sent from the router at one end (the caller). The receiving router must have an inbound destination address that matches the `lid_out_address` on the sending router in order for the dial circuits to connect. The `lid_out_addr` must be an address name that has been previously added using "ADD ISDN-ADDRESS" at the **config>** prompt.

```
Circuit Config> set lid_out_addr router2
```

7. Optionally, you can set the relative priority of dial circuits.

The priority field allows a circuit to preempt another when no channels are available. If an outbound call is made and all the channels are in use, then the priority of the requesting dial circuit is checked against all the active dial circuits. If there is one whose priority is lower than this, then that circuit is disconnected and a call is made for the higher priority dial circuit.

**Note:** Only outbound dial-on-demand circuits will be brought down.

See "Set" on page 748 for more information about priority.

```
Circuit Config> set priority 1
```

8. Optionally, you can delay the time between when a call is established and the initial packet is sent. Use the **set selftest-delay** command. Some ISDN switches start to send data before receiving a signal indicating the complete establishment of the circuit at the destination. Setting a selftest delay can prevent initial packets from being dropped. For example:

```
Circuit Config> set selftest-delay  
Selftest delay(milli-seconds,0 means no delay)[150]?200
```

9. Set the inbound address name.

Use the **set inbound** command. This command is for inbound circuits only. For example:

```
Circuit Config> set inbound  
Assign destination inbound address name [ ]? newyork
```

The inbound destination number is used to match the incoming LID or CallerID with the dial circuit. If there is a match that dial circuit gets the call.

10. Optionally, you can enter the configuration process for the data-link layer protocol that is running on the dial circuit (PPP or Frame Relay).

Use the **encapsulator** command. For example:

```
Circuit Config> encapsulator
```

11. Optionally, you can use the **set bandwidth** command to set the line speed at which to make the call (either 56-kbps or 64-kbps). This provides per-call control for ISDN interfaces. For example:

```
Circuit Config> set bandwidth 56kbps
```

---

## I.431 Switch Variant

Code the switch variant as I.431 when running a leased line over ISDN PRI (T1/J1 only).

## Native I.431 Support

When configuring for Native I.431 support, only one dial circuit should be used. It should be attached to the base net. The I.431 runs only on the ISDN PRI T1 adapter. The speed is fixed at 1.5 Mbps.

**Note:** The multiport ISDN PRI adapters do not support the I.431 switch variant. To utilize a full PRI line, select the channelized variant and assign all the timeslots to one dial circuit.

### Example: Base ISDN net

```
Config> n 5
ISDN Config> set sw i431
ISDN Config> list all
                ISDN Configuration

Maximum frame size in bytes    = 2048
Switch Variant                 = I431 PRI
```

### Example: Dial Circuit

```
Config> n 6
Circuit config: 6>set net 5
Circuit config: 6>list all

Base net                    = 5
```

## Using ISDN



---

## Chapter 53. Configuring and Monitoring the ISDN Interface

This chapter describes the ISDN commands and GWCON commands. It includes the following sections:

- “ISDN Configuration Commands”
- “Accessing the Interface Monitoring Process” on page 736
- “ISDN Monitoring Commands” on page 736
- “ISDN and the GWCON Commands” on page 741
- “ISDN Dynamic Reconfiguration Support” on page 743

### Notes:

1. ISDN interfaces have both ELS messages and cause codes that you can use to monitor ISDN-related activity. See *Event Logging System Messages Guide*
2. The ISDN, Q931, CEME, LAPD, and DIAL ELS subsystems are available.

---

## ISDN Configuration Commands

Table 100 describes the ISDN configuration commands, and the following sections explain the commands. Enter these commands at the ISDN Config> prompt.

Table 100. ISDN Configuration Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Block-calls	Blocks incoming calls from a specific caller.
Disable	Valid only for BRI. Disables Power Source 1 detection.
Enable	Valid only for BRI. Enables Power Source 1 detection.
List	Displays the ISDN configuration.
Remove	Removes DN0 entries from the ISDN configuration.
Set	Sets the frame size, local address, no-answer timeouts, number of retries after no answer, type of ISDN switch, directory numbers, SPIDS, and TEI.
Cause Code	Stops further processing attempts to establish a connection through an interface.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## Block-Calls

Use the **block-calls** commands to block incoming calls. Caller numbers to be blocked must be added to the authentication list. The maximum number of caller blocked calls is 16 per interface.

Call block can be used for:

- An unsolicited call being constantly received.
- Network bringup/test where you need to ignore certain calls.

### Syntax:

```
block-calls          add  
                      list  
                      remove
```

**Add** Adds a caller's number to be blocked.

**List** Lists the callers' numbers to be blocked.

## ISDN Configuration Commands

### Remove

Removes a caller's number for the list to be blocked.

## List

The **list** command displays the current ISDN configuration.

### Syntax:

**list**

### Example: list

```
ISDN Configuration
Local Network Address Name      = local2216
Local Network Address:Subaddress = 2542216:

Maximum frame size in bytes     = 2048
Outbound call address Timeout   = 180 Retries = 2
Switch Variant                  = NT DMS-250
DN0 (Directory Number 0)       = 2542216
No circuit address accounting information being kept.

T1/J1 Interface Parameters:
LBO                             = 00.0 dB
Code                            = B8ZS
ZBTSI                           = Disabled
ESF-Data-Link                   = ANSI-IDLE
```

## Remove

The **remove** command lets you remove DN0 or DN1 entries that you set previously with the **set DN0** or **set DN1** command.

### Syntax:

**remove** DN0-entry...

### Example:

```
remove DN0
```

## Set

The **set** command configures frame size, addresses, and timeouts. It also specifies the switch-variant and TEI number. For PRI, the terminal endpoint identifier (TEI) is always zero (0).

### Syntax:

```
set framesize...
      interface
      interface frame
      local-address-name...
      RAI-type1
      retries-call-address...
      switch-variant...
      dn0...
```

---

1. PRI only

2. Channelized only

### framesize 1024 or 2048 or 4096 or 8192

Sets the size of the network layer portion of frames transmitted and received on the ISDN interface. Data link and MAC layer headers are not included. You must set the ISDN frame size so that it is greater than or equal to the frame size configured for the dial circuits using the ISDN interface.

For PPP dial circuit interfaces, you can change the PPP MRU using the **set lcp options** command. The ISDN frame size must include enough bytes for the PPP MRU and the PPP header.

**Note:** If you choose a frame size of 1024, PPP will not work over the ISDN dial circuit, since the minimum frame size for PPP is 1500.

For FR dial circuit interfaces, you can change the frame size using the **set framesize** command. The ISDN frame size must be greater than or equal to the FR frame size.

If a dial circuit's frame size is greater than the ISDN frame size, then the dial circuit's frame size is decreased at router initialization.

#### Example:

```
set framesize
Framesize in bytes (1024/2048/4096/8192) [1024]? 2048
```

### interface

For PRI only. Sets the following interface parameter values for T1 and E1 lines.

#### For T1 PRI:

**lbo** The attenuation of the signal transmitted by the router's T1 port. This information is provided by the service provider.

#### Valid Values:

```
a= -00.0 dB
b= -07.5 dB
c= -15.0 dB
d= -22.5 dB
```

**Default Value:** a

**code** This information is provided by the service provider.

**Valid Values:** B8ZS or AMI

**Default Values:** B8ZS

#### interface frame

Choices are D4 or ESF. This specifies the T1 multiframe format. Only ESF is supported for non-channelized mode. Interface frame is configured under the base ISDN net menu.

#### Example:

```
set interface frame
Circuit config: 10>set interface frame
```

**ZBTSI** Zero Byte Time Slot Inversion. This information is provided by the service provider.

**Valid Values:** Enabled or Disabled

**Default Value:** Disabled

## ISDN Configuration Commands

### **esf-data-link**

The service subscription. This information is provided by the service provider.

#### **Valid Values:**

ANSI-T1.403  
ANSI-IDLE  
AT&T-IDLE

**Default Value:** ANSI-T1.403

### **RAI-type**

Choices are ANSI or Japanese. This specifies the method of indicating RAI on the T1 line when using D4 framing. ANSI RAI is indicated by a value of 0 in bit 2 of all channels. Japanese RAI is indicated by a value of 1 in the S-bit position of frame 12. RAI type is configured under the base ISDN net menu.

### **For E1 PRI:**

**code** This information is provided by the service provider.

**Valid Values:** HDB3 or AMI

**Default Value:** HDB3

**crc4** Specifies whether the router's E1 port will transmit crc4 code words and check them in the received frames. This information is provided by the service provider.

**Valid Values:** Enabled or Disabled

**Default Value:** Enabled

### **local-address-name** *address name*

This is the network address name of the local ISDN interface. This address name must match one of the names that you defined at the Config> prompt using the **add isdn-address** command.

**Valid Values:** Any valid address

**Default Value:** None

#### **Example:**

```
set local-address-name  
Assign local address name []? line-1-local
```

### **retries-call-address** *value*

Some telephone service providers impose restrictions on automatic recalling devices to limit the number of successive calls to an address that is inaccessible or that refuses those calls. **Retries-call-address** specifies the maximum number of calls the router attempts to make at one time. Setting **retries-call-address** to 0 causes the router to bring up all circuits at once.

If you set the switch-variant to INS64, you cannot change the **retries-call-address** default. It is fixed at 2.

**Valid Values:** 0 to 30

**Default Value:** 23 (2 for BRI)

### **switch-variant** *4ess or 5ess or auspri usni2 or ins1500 or dms250 or channel*

Specifies the model of the switch to which this ISDN interface is connected. You can choose switch-variants/service type for the ISDN Primary Rate interface from the following lists.

### Valid Values ISDN Primary Rate Interface (PRI)/Channelized T1/E1:

- AT&T 5ESS (North America)
- AT&T 4ESS (North America)
- Australia (AUSTEL)
- INS-Pri (Japan, NTT)
- National ISDN 2 (North America)
- NET 5 (Euro-ISDN, ETSI)
- Northern Telecom 250 (DMSPRI)
- Native I.431 (valid for T1 only)
- Channelized T1/E1

**Default Value:** DMSPRI

### **dn0** *directory number 0*

To accept inbound calls **DN0** must match the network dial address (telephone number) you configured using the **set local-address-name** command. If DN0 is not configured no check is made and all calls will be accepted. If the switch does not provide the called party number in the incoming setup message, DN0 should not be configured. See on page 735 for additional information.

#### **Example:**

```
set dn0
Enter DN0 (Directory-Number-0) [ ]? 5088981234
```

**Note:** This applies to all Basic Rate ISDN switch variants:

- DN0 and DN1 are used to verify that the incoming call is being delivered to the correct ISDN destination.
- If the destination number (Called Party Number) in the ISDN call being delivered does not match either DN0 or DN1, then the call is rejected.
- If the user wishes to bypass the destination verification checking, then do not configure either DN0 or DN1. If the ISDN line provisioning has only one DN, and the user wishes to use the destination verification then you must configure DN0. Do not configure DN1 unless the ISDN line is provisioned for two DNs.
- When configuring the SPIDs and TEIs, always be sure to configure the first SPID (SPID[0]) and TEI (TEI[0]). It will cause errors if you have a SPID[1] or TEI[1] configured without SPID[0] or TEI[0] configured.

## Cause Code

Use the **Cause Code** command to prevent the router from retrying to establish a connection through the ISDN interface when it receives a “specified” (valid value) response. Enter these commands at the Cause Config> prompt.

#### **Syntax:**

```
cause code                ? (Help)
                             add
                             list
                             remove
                             exit
```

## ISDN Configuration Commands

Table 101. ISDN Cause Codes Command Summary

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Add	Adds cause code entries to the ISDN configuration.
List	Displays the cause code lists for the ISDN configuration.
Remove	Removes cause code entries from the ISDN configuration.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

**Add** Use the **add** command to add a cause code to an ISDN configuration.

**Valid Values:** Any hexadecimal value between 01 and FF

**Default Value:** None

**Syntax:** cause code add *value*

**Example:** add FF

**List** Use the **list** command to show the cause code list of an ISDN configuration.

**Syntax:** cause code list

**Remove**

Use the **remove** command to remove a cause code from an ISDN configuration.

**Valid Values:** Any hexadecimal value between 01 and FF

**Default Value:** None

**Syntax:** cause code remove *value*

**Example:** remove FF

---

## Accessing the Interface Monitoring Process

To access the interface monitoring process for ISDN, enter the following command at the GWCON (+) prompt:

```
+ network #
```

Where # is the number of the ISDN interface. You cannot directly access the monitoring process for dial circuits, but you can monitor the dial circuits that are mapped to the ISDN interface.

---

## ISDN Monitoring Commands

The following sections explain the ISDN operating commands which allow you to view the accounting entries, calls, circuits, parameters, and statistics of the ISDN interfaces. Enter these commands at the ISDN> prompt.

Table 102. ISDN Monitoring Command Summary

Monitoring Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See "Getting Help" on page 10.
Block-calls	Blocks incoming calls from a specific caller.

Table 102. ISDN Monitoring Command Summary (continued)

Monitoring Command	Function
Calls	Displays the number of completed and attempted connections made for each dial circuit mapped to this interface since the last time statistics were reset on the router.
Channels	Displays the statistics for the channels on the ISDN Primary Rate Interface.
Circuits	Displays the status of all data circuits configured on the ISDN interface.
Dial-dump	Displays the operation characteristics of the specified dial circuit.
L2_counters	Lists the L2/L1 states along with some L2 counters.
L3_counters	Lists counters of set ups sent/received/accepted.
TEI	Lists status of TEI's (BRI only)
Parameters	Displays the current parameters for the ISDN interface.
Signaling-L3	This command is to be used only by product support personnel.
Statistics	Displays the current statistics for the ISDN interface.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page 10.

## Block-Calls

Use the **block-calls** commands to block incoming calls. Caller numbers to be blocked must be added to the authentication list. The maximum number of caller blocked calls is 16 per interface.

### Syntax:

```
block-calls          add
                   list
                   remove
```

**Add** Adds a caller's number to be blocked.

**List** Lists the callers' numbers to be blocked.

### Remove

Removes a caller's number for the list to be blocked.

## Calls

Use the **calls** command to list the number of completed and attempted connections made for each dial circuit mapped to this interface since the last time statistics were reset on the router.

### Syntax:

```
calls
```

### Example:

```
calls
Net Interface Site Name      In   Out  Rfsd  Blckd
  4   PPP/1   v403          2    0    0     0
```

Unmapped connection indications: 0

**Net** Number of the dial circuit mapped to this interface.

### Interface

Type of interface and its instance number.

## ISDN Monitoring Commands

### Site Name

Network address name of the dial circuit.

**In** Inbound connections accepted for this dial circuit.

**Out** Completed connections initiated by this dial circuit.

**Rfsd** Connections initiated by this dial circuit that were refused by the network or the remote destination port.

**Blckd** Connection attempts that the router blocked. The router blocks connection attempts if all available channels are in use, if the maximum retries are used up and the router is waiting for the timer to count down, or if Layer 1 is up, but Layer 2 is down.

### Unmapped connection indications:

Connection attempts that were refused by the router because there were no enabled dial circuits that were configured to accept the incoming calls.

## Channels

The **channels** command lists the statistics for a channel on the ISDN Primary Rate Interface.

### Syntax:

channels

## Circuits

The **circuits** command shows the status of the dial circuits configured on the ISDN interface that are in the state of "Up" or "Available".

### Syntax:

circuits

### Example:

```
circuit
Net Interface MAC/Data-Link State Reason Duration
4 PPP/1 Point to Point Up B1 SelfTest 91:24:03
5 PPP/2 Point to Point Up B2 Inbound 91:24:00
```

**Net** Number of the dial circuit mapped to this interface

### Interface

Type of interface and its instance number.

### MAC/Data-Link

Type of data-link protocol configured for this dial circuit.

**State** Current state of the dial circuit:

**Up** Currently connected.

### Available

Not currently connected, but available.

### Disabled

Dial circuit disabled.

**Down** Failed to connect because of a busy dial circuit or because the link-layer protocol is down.

### Reason

Reason for the current state:



### **nnn\_Data**

(Where nnn is the name of a protocol.) The circuit is up because a protocol had data to send.

### **Rmt Disc**

Remote Disconnect. The circuit is either down or available because the remote destination disconnected the call.

### **Opr Req**

Operator Request. The circuit is available because the last call was disconnected by a monitoring command.

### **Inbound**

The circuit is up because the circuit answered an inbound call.

### **Restoral**

The circuit is up because of a WAN-Restoral operation.

### **Self Test**

The circuit was configured as static (idle time=0) and successfully connected once it was enabled.

### **Duration**

Length of time that the circuit has been in the current state.

## Dial-dump

Use the **dial-dump** command to display the operation characteristics of the specified dial circuit.

### **Syntax:**

**dial-dump** *circuitname*

## L2\_Counters

Use the **L2\_counters** command to list the L2/L1 states along with some L2 counters.

### **Syntax:**

**L2\_counters**

## L3\_Counters

Use the **L3\_Counters** command to list counters of set ups sent/received/accepted.**Syntax:**

**L3\_counters**

## TEI

Use the **TEI** command to list the status of TEIs. For BRI only.

### **Syntax:**

**parameters**

### **Example:**

**parameters**  
ISDN Port parameters:

Local Address Name: v1233  
Local Network Address: 20

## ISDN Monitoring Commands

```
Local Network Subaddress:
Frame Size:             2048
TEI 0:                 Automatic
TEI 1:                 Automatic

Switch Variant:        AT&T 5ESS (United States)
Multipoint Selection:  Multipoint
Directory Number 0:    20
Outbound call address Timeout: 180      Retries: 0
```

## Parameters

Use the **parameters** command to display the current ISDN configuration.

### Syntax:

#### parameters

### Example:

```
parameters
ISDN Port parameters:

Local Address Name:      v1233
Local Network Address:  20
Local Network Subaddress:
Frame Size:             2048
TEI 0:                 Automatic
TEI 1:                 Automatic

Switch Variant:        AT&T 5ESS (United States)
Multipoint Selection:  Multipoint
Directory Number 0:    20
Outbound call address Timeout: 180      Retries: 0
```

## Statistics

Use the **statistics** command to display the current statistics for this ISDN interface.

### Syntax:

#### statistics

### Example for PRI with E1:

```
statistics
Link: Active   ISDN Firmware: 1.0   Handler State: Running

Transmit  D Channel   Receive  D Channel
Packets      68422   Packets    68419
Bytes      411656   Bytes    413592
Overflow      23   Overflow     3
Underrun      0   Too Long     6
                Abort     4
                CRC error  8
                Misaligned  3

Transmit  B Channels  Receive  B Channels
Packets      1499094  Packets    1499228
Bytes      59955660  Bytes    59951780
Overflow      0   Overflow     90
Underrun      0   Too Long    171
                Abort     139
                CRC error  232
                Misaligned  72

E1 Status Register           E1 Error Count Registers
Receive AIS                  : Off  CRC6 Errors:    4
Receive RAI                  : Off  LCV Errors:   38
Receive Carrier Loss: Off  FEB Errors:   11
Receive Loss of Sync: Off  FAS Errors:   24
```

### Example for PRI with T1 using I.431:

```

statistics
Transmit                               Receive

Packets                                0      Packets                                0
Bytes                                  0      Bytes                                  0
Overflow                               68480  Overflow                               0
Underrun                               0      Too Long                              0
                                          Abort                                  0
                                          CRC error                              0
                                          Misaligned                             0

T1 Status Register                     T1 Error Count Registers

Receive AIS      : Off  LCV Errors:      0
Receive RAI     : Off  CRC6 Errors:    0
Receive Carrier Loss: Off Sync Errors:  47937328
Receive Loss of Sync: On

T1 PRM Events                               Local           Remote

CRC Error                                0              0
Controlled Slip                          0              0
Line Code Violation                      0              0
Frame Sync Bit Error                     0              0
Severely Errored Frame                   0              0
Payload Loopback Active                   0              0
PRMs Processed (1/sec)                   0              0

```

---

## ISDN and the GWCON Commands

While ISDN has its own monitoring process for monitoring purposes, the router also displays configuration information and complete statistics for devices and circuits if you use the **interface**, **statistics**, and **error** commands from the GWCON environment. You can also use the GWCON **test** command to test DCEs and circuits.

**Note:** Issuing the **test** command to the ISDN interface causes the current calls to be dropped and re-dialed.

## Interface—Statistics for ISDN Interfaces and Dial Circuits

Use the **interface** command at the GWCON prompt (+) to display statistics for ISDN interfaces and dial circuits.

To display statistics for a dial circuit, enter the **interface** command followed by the interface number of the dial circuit. For ISDN interfaces, information is displayed on a D and B channel basis. (This is the same information that is displayed by the ISDN Talk 5 **statistics** command.)

### Example:

```
interface 2
```

```

Nt Nt'  Interface  Slot-Port          Self-Test  Self-Test  Maintenance
2 2   ISDN/0     Slot: 8 Port: 1    Passed     Failed     Failed
                               1          0          0

ISDN Base Net MAC/data-link on ISDN Primary Rate interface
Link: Active ISDN Firmware: 1.0 Handler State: Running

Transmit  D Channel  Receive  D Channel

Packets      36      Packets      36
Bytes       214      Bytes       214
Overflow      0      Overflow      0
Underrun      0      Too Long      0
                               Abort          0
                               CRC error      0
                               Misaligned     0

Transmit  B Channels  Receive  B Channels

Packets      0      Packets      0

```

## ISDN and the GWCON Commands

```

Bytes          0      Bytes          0
Overflow       0      Overflow       0
Underrun       0      Too Long      0
                Abort        0
                CRC error    0
                Misaligned   0

T1 Status Register      T1 Error Count Registers

Receive AIS      : Off  LCV Errors:      0
Receive RAI     : Off  CRC6 Errors:     0
Receive Carrier Loss: Off Sync Errors:    0
Receive Loss of Sync: Off

T1 PRM Events          Local      Remote

CRC Error              0          0
Controlled Slip        0          0
Line Code Violation    0          0
Frame Sync Bit Error   0          0
Severely Errored Frame 0          0
Payload Looback Active 0          0
PRMs Processed (1/sec) 365        367

```

To display the following statistics for a dial circuit, use the **interface** command followed by the interface number of the dial circuit.

### Example:

```

interface 3
Nt Nt' Interface      Self-Test Passed Self-Test Failed Maintenance Failed
3 2  PPP/1            1          0          0

```

Point to Point MAC/data-link on ISDN Primary Rate interface

The following list describes the output for both ISDN and dial circuits.

- Nt** Serial line interface number or dial circuit interface number.
- Nt'** If *Nt* is a dial circuit, this is the interface number of the ISDN interface to which the dial circuit is mapped.
- Interface** Interface type and its instance number.
- Slot** The slot that contains the ISDN adapter
- Port** The port number on the ISDN adapter.
- Self-Test Passed** Number of self-tests that succeeded.
- Self-Test Failed** Number of self-tests that failed.
- Maintenance: Failed** Number of maintenance failures.

## Configuration—Information on Router Hardware and Software

Enter the **configuration** command at the GWCON (+) prompt to display information about the router hardware and software. It includes a section that displays the interfaces configured on the router along with the state of the interface.

If a dial circuit is configured to dial-on-demand, the state of the dial circuit is always displayed as Up whether or not it is connected. In this case Up means that the dial circuit is either connected or available.

If a dial circuit is configured as a static circuit, the state indicates Up only if the dial circuit is connected. (Refer to “Configuration” on page 112 for a sample output from the **configuration** command.

---

### ISDN Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

#### CONFIG (Talk 6) Delete Interface

ISDN supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

#### GWCON (Talk 5) Activate Interface

ISDN supports the GWCON (Talk 5) **activate interface** command with no restrictions.

#### GWCON (Talk 5) Reset Interface

ISDN does not support the GWCON (Talk 5) **reset interface** command.

## ISDN and the GWCON Commands

---

## Chapter 54. Configuring and Monitoring Dial Circuits

This chapter describes how to configure dial circuits on a dial circuit interface mapped to a V.25 bis or ISDN interface. It contains the following sections:

- “Dial Circuit Configuration Commands”
- “Dial Circuit Monitoring Commands” on page 751
- “Dial Circuits Dynamic Reconfiguration Support” on page 751

### Notes:

1. PPP dial circuit interfaces can use an ISDN or V.25 bis network as the base-network interface.
2. FR dial circuit interfaces can use an ISDN or a V.25 bis network as the base network interface.
3. Switched SDLC Call-In dial circuit interfaces use a V.25 bis network as the base-network interface.
4. X.25 circuits can be used over ISDN D-channels for BRI.

For information on how to configure dial circuits for use with:

- ISDN interfaces, see “Chapter 52. Using the ISDN Interface” on page 717.
- V.25 bis interfaces, see “Chapter 50. Using the V.25 bis Network Interface” on page 701.

---

## Dial Circuit Configuration Commands

Table 103 describes the dial circuit configuration commands. Enter the dial circuit configuration commands at the `Circuit Config>` prompt. You must restart the router for configuration changes to take effect.

To access the `Circuit Config>` prompt, enter the **network** command followed by the interface number of the “dial circuit”. (The dial circuit number was assigned when you entered the **add device dial-circuit** command.) You can enter the **list devices** command at the `Config>` prompt to display a list of the dial circuits that you added.

*Table 103. Dial Circuit Configuration Commands Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Delete	Deletes the inbound call settings from the dial circuit configuration.
Encapsulator	Allows you to change the data-link protocol configuration.
List	Displays the dial circuit configuration parameters.
Set	Configures the dial circuit for inbound or outbound calls, maps the dial circuit to a serial line interface, and sets addresses, idle timeout, priority, lid_out address, inbound destination, and self-test delay.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

### Delete

Use the **delete** command to remove the inbound call settings from the dial circuit configuration.

### Syntax:

## Configuring Dial Circuits

delete *inbound destination*

**inbound** *destination*

Removes both the INBOUND destination and the ANY\_INBOUND settings from the dial circuit configuration. This causes the dial circuit to accept calls only from callers that have a phone number that matches the *destination* parameter.

## Encapsulator

Use the encapsulator command to enter the configuration process for the link-layer protocol (for example, PPP, Frame Relay, X.25, SDLC) that is running on the dial circuit interface.

**Note:** The default for a dial circuit interface created via the **add device dial-circuit** command is PPP. To change the link layer type, at the Config> prompt:

- For Frame Relay, enter **set data-link frame-relay**.
- For SDLC, enter **set data-link sdlc**.

**Syntax:**

encapsulator

The following example shows that the PPP configuration process is entered when the encapsulator command is used for a PPP dial circuit interface.

**Example:**

```
encapsulator
Point-to-Point user configuration
PPP Config>
```

Be aware of the following when you configure a dial circuit that uses a V.25 bis interface as the base network:

- The V.25 bis interface pre-defines clocking as external. The modem (DCE) controls the clock speed. You cannot configure clocking, encoding, and other HDLC parameters as part of the dial circuit configuration.

Be aware that you cannot configure HDLC parameters of the dial circuit configuration when you configure PPP or Frame Relay for ISDN. Physical layer parameters are configured on the ISDN interface.

For information on configuring the PPP protocol, refer to “Chapter 36. Configuring Serial Line Interfaces” on page 427 or refer to “Chapter 43. Using Point-to-Point Protocol Interfaces” on page 581.

For information on configuring the Frame Relay protocol, see “Chapter 41. Using Frame Relay Interfaces” on page 497 or “Chapter 42. Configuring and Monitoring Frame Relay Interfaces” on page 525.

For information on configuring or monitoring SDLC interfaces, see “Chapter 48. Using SDLC Interfaces” on page 675 or “Chapter 49. Configuring and Monitoring SDLC Interfaces” on page 677.

For information on configuring or monitoring X.25 interface, see “Chapter 38. Configuring and Monitoring the X.25 Network Interface” on page 437.

To return to the Circuit Config> prompt, use the **exit** command.



## List

Use the **list** command to display the current dial circuit configuration.

For more information about I.430 and I.431, see “I.431 Switch Variant” on page 728.

### Syntax:

**list**

-

### Example:

**Note:** Options listed depend upon the type of interface used. All options may not be shown for all interface types.

```
list
Any inbound          set
Bandwidth:          64
Base net:            1
Callback:            yes
Calls:               inbound
Destination name:    remote-site-sanfrancisco
Idle char:           7E
Idle timer:          = 60 sec
Inbound calls        allowed
Inbound dst name:    local-1
LID out address:     1234
LID used:            enabled
Net #:               2
Outbound calls       allowed
Priority:             8
SelfTest Delay Timer: = 0 ms
Time slot:           1 4 5 8
```

### Any inbound

Displays this setting when inbound calls that do not match any other dial circuit are mapped to this circuit and accepted as inbound calls.

### Bandwidth

Displays the bandwidth value in kbps.

### Base net

Displays the name of the serial line interface to which this dial circuit is mapped.

### Callback

Displays the setting of this option.

**Calls** Displays the setting of this option.

### Destination name

Displays the network address name to be called for outbound circuits, and the default comparison address used by the LID mechanism for inbound calls.

### Idle char

Displays the idle character used for I.43x or channelized circuits.

### Idle timer

Displays the idle timer setting in seconds. The range is 0 to 65535; 0 indicates that this is a dedicated circuit (leased line).

### Inbound calls allowed

Displays this parameter when the circuit is configured to accept inbound calls.

### Inbound dst name

Displays this parameter if the circuit is configured to accept inbound calls

## Configuring Dial Circuits

that do not match any other addresses. This is an alternate comparison address name used by the LID mechanism for inbound calls.

### LID out address

Displays the name of the dial circuit connecting the routers.

### LID used

Displays the setting of this option.

**Net #** Displays the base circuit number.

### Outbound calls allowed

Displays this parameter when the circuit is configured to initiate outbound calls.

### Priority

Displays the setting of this parameter.

### SelfTest Delay Timer

Displays the self-test delay timer setting in milliseconds. The range is 0 to 65535; 0 indicates no delay.

### Time slot

Displays the list of slots to use for this dial circuit.

## Set

Use the **set** command to map the dial circuit to an interface (for example: ISDN or V.25 bis), configure the dial circuit for inbound and/or outbound calls, and set destination addresses, inbound addresses, idle timeout, and self-test delay.

### Note:

#### Notes:

1. If you are running SDLC, I.430, I.431, Channelized, or X.25 on a dial circuit, you will be unable to use the **set** command to change the following parameters as the software will use specific defaults:
  - Any\_inbound - any\_inbound is set
  - Calls - inbound
  - Destination - default address
  - Inbound destination - no destination inbound address
  - Idle - 0
  - Lid\_out\_addr - no LID name
  - Lid\_used - disabled
  - Priority - 8
  - Self\_test\_delay

### Syntax:

```
set                any_inbound
                    bandwidth...
                    callback...
                    calls...
                    destination...
                    idle...
                    idle-char...
                    inbound destination...
```

`lid_out_addr...`

`lid_used...`

`net...`

`priority...`

`selftest-delay...`

`timeslot...`

### **any\_inbound**

Specifies that inbound calls that do not match any other dial circuit will be mapped to this circuit and accepted as inbound calls.

### **bandwidth** *kbps*

Sets the bandwidth, in kbps, for I.430 and Channelized T1/E1 circuits.

#### **Valid values:**

For I.430: 64 or 128

For Channelized: 56 or 64

#### **Default value:** 64

### **callback** [*Yes or No*]

The callback feature uses the callers telephone number to verify the call against an authentication table and then disconnects the incoming call. Callback then makes an outgoing call to the same caller. Callback should always be disabled. The default is no.

### **calls** [*outbound or inbound or both*]

Restricts this dial circuit to initiating outbound calls only, accepting inbound calls only, or both initiating and accepting calls. The default is both.

### **destination** *address\_name*

This parameter is required for the dial circuit to operate. It specifies the network dial address of the remote router to which this dial circuit will connect. The LID protocol uses this parameter as the default comparison address for incoming calls. This parameter must match an address name that you assigned using the `Config>` prompt with either the **add isdn address** command or the **add v25-bis address** command.

#### **Example:** `set destination remote-site-sanfrancisco`

### **idle** *# of seconds*

Specifies a timeout period for the circuit. If there is no protocol traffic over the circuit for this specified time period, the dial circuit hangs up. The range is 0 to 65535, and the default is 60 seconds. A setting of zero specifies that there is no timeout period and that this is a dedicated circuit.

#### **Notes:**

1. For WAN Restoral operations, you must set the idle timeout to 0.
2. On a I.43x, X.25 or Channelized circuit, you cannot set this parameter.

### **idle-char**

Specifies the idle character used for channelized circuits.

**Note:** You cannot configure this parameter for regular ISDN circuits.

**Valid values:** 7E or FF

**Default value:** FF

## Configuring Dial Circuits

**Example:** `set idle-char 7E`

### **inbound-destination** *address\_name*

Set this parameter if the dial circuit is set up for both inbound and outbound calls and if this router's local dial address is different from the destination dial address that the remote router dials. For example, the numbers would be different if one of the routers must go through a PBX, international, or inter-LATA exchange. This parameter must match an address name that you assigned at the `Config>` prompt with either the **add isdn address** command or the **add v25-bis address** command. The inbound destination number is used to match the incoming LID or CallerID with the dial circuit. If there is a match that dial circuit gets the call.

**Example:** `set inbound remote-site-1`

### **lid\_out\_addr** *address\_name*

The `lid_out_addr` is the name of a dial circuit between two routers. When more than one circuit is configured between two routers (parallel circuits), then there needs to be a way to unambiguously know which dial circuit connects between them. For this purpose, a `lid_out_addr` is sent from the router at one end (the caller). At the receiving end the other router configures the same string as the inbound destination name. The `lid_out_addr` must be an address name that has previously been added using **ADD ISDN-ADDRESS** from the `config>` prompt.

### **lid\_used** [yes or no]

Suppresses the exchange of logical ids for circuits to devices that do not support logical ids.

**Valid values:** Yes or No

**Default value:** Yes

### **net** #

Sets the base network number of the interface to the # of the serial line interface to which you want to map this circuit.

**Example:**

```
Circuit Config> set net
Base net for this circuit [ ]? 2
```

### **priority**

The priority field allows an outbound dial-on-demand circuit to preempt another when no channels are available. If a call request is made and all the channels are in use, then the priority of the requesting dial-on-demand circuit is checked against all the active dial-on-demand circuits. If there is an outbound dial-on-demand circuit with lower priority, then that circuit is disconnected and a call is made for the higher priority dial-on-demand circuit. Only the priority on the outbound end of a connection is considered. An inbound dial-on-demand call will not be taken down in favor of a higher priority outbound call. An inbound dial-on-demand call cannot cause a lower priority call to be taken down.

### **selftest-delay** # of milliseconds

Use this parameter to delay the time between when the call is established and the time when the initial packet is sent. Setting a `selftest-delay` can prevent initial packets from being dropped. The range is 0 to 65535, and the default is 150.

For V.25 bis dial circuits, adjust this setting if your modems take extra time to synchronize.

## Configuring Dial Circuits

For ISDN dial circuits, you may need to adjust this setting for dial-on-demand links because some ISDN switches start to deliver data before signaling the complete establishment of the circuit at the destination end.

### **timeslot** *list of slots*

Specifies a slot or list of slots to use for this dial circuit. Your service provider will issue the number of the slots you can use for the circuit. Specify the list as slot numbers separated by blanks.

**Note:** You can only use this parameter for Channelized T1/E1 circuits.

### **Valid values:**

For Channelized T1: 1 to 24

For Channelized E1: 1 to 31

**Default value:** None

**Example:** set timeslot 1 4 5 8

---

## Dial Circuit Monitoring Commands

Table 104 describes the dial circuit monitoring commands. Enter the dial circuit monitoring commands at the `Circuit Config>` prompt. You must restart the router for monitoring changes to take effect.

*Table 104. Dial Circuit Configuration Commands Summary*

Command	Function
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page 10.
Callback	Adds, deletes, or lists the information in the authentication cache.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page 10.

## Callback

Use the **callback** command to add, delete or list the information in the authentication cache.

### **Syntax:**

```
callback                add  
                        delete  
                        list
```

**add** Adds a callback number to the authentication lists.

**delete** Deletes a callback number from the authentication lists

**list** Lists the callback numbers and other information in the authentication list.

---

## Dial Circuits Dynamic Reconfiguration Support

This section describes dynamic reconfiguration (DR) as it affects Talk 6 and Talk 5 commands.

## Configuring Dial Circuits

### CONFIG (Talk 6) Delete Interface

Dial Circuits supports the CONFIG (Talk 6) **delete interface** command with no restrictions.

### GWCON (Talk 5) Activate Interface

Dial Circuits supports the GWCON (Talk 5) **activate interface** command with the following consideration:

Base net must already be active. See data-link-specific restrictions.

### GWCON (Talk 5) Reset Interface

Dial Circuits supports the GWCON (Talk 5) **reset interface** command with the following consideration:

You cannot reset a Dial Circuit interface if any Dial Circuit parameters have changed. Reset is allowed if the only parameters changed by the reset are associated with data-links running on top of the circuit. These parameters have restrictions associated with that data-link.

---

## Part 4. Appendixes





---

## Appendix A. Quick Configuration Reference

### Important

If you are attempting to configure or monitor your IBM 2216 and your service terminal is unreadable, see "Service Terminal Display Unreadable" in 2216 Nways Multiaccess Connector Service and Maintenance Manual.

---

### Quick Configuration Tips

Before starting the Quick Configuration process, read these notes:

1. Attach an ASCII terminal to the service port to run the Quick Configuration program. See the *Installation and Initial Configuration Guide*.
2. Any existing configuration for a particular item will be removed if that item is configured through Quick Configuration.
3. Configuration is done at the level of the *interface*, which corresponds to a single *port* on an adapter. Because different types of adapters have differing numbers of ports, you may have to configure up to eight ports to activate all of the interfaces on the adapter (for example, the X.21 adapter, FC 2291).

**Note:** The ESCON adapter or PCA can have up to 16 virtual interfaces configured on one physical interface. All of the virtual interfaces are associated with a single port.

4. Using the **add device** command, you must "add" all desired network interfaces or virtual interfaces for the adapters installed in your IBM 2216. This must be done prior to running Quick Configuration. To add an interface, see "Add" on page 72.
5. Using the **network** command, you must enter the network interface configuration information. See "Network" on page 96.

### Making Selections

On the panels that you view when using the Quick Configuration program, the information shown in brackets, [ ], is the default. For example:

Configure Bridging? (Yes, No, Quit): [Yes]

- To use the default Yes, press **Enter**.
- To use a value other than the default, such as No or Quit, choose from the values in the parentheses.
- If no value appears in the brackets, there is no default and you must type a value.

### Exiting and Restarting

- To restart the current Quick Configuration section at any time, type **r**. For example, if you are in the Interface Configuration section, type **r** and press **Enter** to return to the beginning of that section.
- To exit Quick Configuration, type **q** and press **Enter**. The Config> prompt will appear.
- To restart Quick Configuration from the Config> prompt, type **qc** and press **Enter**.

## When You're Done

- Once you have completed your configuration, you must restart the device for the configuration to take effect. At the end of the Quick Configuration program, you are given this option.

---

## Starting the Quick Configuration Program

The following sections describe sample configurations using the Quick Configuration program (**qconfig**).

To start the quick configuration program, enter **qc** at the Config> prompt.

The program displays the following panel after starting.

```
Router Quick Configuration for the following:
o Bridging
  Spanning Tree Bridge (STB)
  Source Routing Bridge (SRB)
  Source Routing Transparent Bridge (SRT)
o Protocols
  IP (including OSPF, RIP, and SNMP)
  IPX
  DNA (DECnet)

Event Logging will be enabled for all configured subsystems
with logging level 'Standard'

Note: Please be warned that any existing configuration for a particular item
will be removed if that item is configured through Quick Configuration
```

*Event logging* records system activity, status changes, data transmission and reception, data and internal errors, and service requests. The logging level is set to standard (the default). For more information about error logging, refer to the *Event Logging System Messages Guide*.

During Quick Configuration you can:

1. Configure bridging
2. Configure protocols
3. Restart the device

---

## Configuring LAN Emulation

If you added an ATM device, you will see the following prompts:

```
*****
LAN Emulation Configuration
*****

Type 'Yes' to Configure LAN Emulation
Type 'No' to skip LAN Emulation Configuration
Type 'Quit' to exit Quick Config

Configure LAN Emulation? (Yes, No, Quit): [Yes]
```

You can configure either Token-Ring or Ethernet LAN Emulation clients from this question.

## Configuring Bridging

```
*****  
Bridging Configuration  
*****  
  
Type 'Yes' to Configure Bridging  
Type 'No' to skip Bridging Configuration  
Type 'Quit' to exit Quick Config  
  
Configure Bridging? (Yes, No, Quit): [Yes]
```

1. In response to Configure Bridging, take one of the following actions:
  - Enter **y** to display the bridging configuration prompts. The prompts that appear depend on your network configuration.
  - Enter **n** to skip the bridging configuration and continue with quick configuration.
  - Enter **q** to exit quick configuration. This displays the `Config>` prompt. To reenter quick configuration, enter **qc** after this prompt.
2. If you choose to configure bridging, Spanning Tree Bridging (STB) will be enabled on all LAN interfaces. You will see the following panels:

```
Type 'r' any time at this level to restart Bridging Configuration  
  
STB will be enabled on all LAN interfaces
```

Enter **y** to configure SRT bridging. Otherwise, enter **n**. For each Token-Ring interface in the configuration, you will be prompted to enable Source Routing on the interface.

```
Configure SRT Bridging? (Yes, No): [Yes]  
You are now configuring the Source Routing part of SRT Bridging  
Bridge Number (hex) of this Router (1-F): [A]
```

3. Enter a bridge number, which is a hexadecimal value from 1 to F that is unique between two parallel segments.

```
Interface 0 (Port 1) is of type Token Ring  
Configure Source Routing on this interface (Yes, No): [Yes]
```

4. Enter **y** to configure source routing on the interface. The console displays the next two lines.

```
Configuring Interface 0 (Port 1)  
Segment Number (hex) of this Interface (1-FFF): [A1]
```

**Note:** The port number increases by one because source routing bridging does not allow a port number of zero.

A unique hexadecimal value from 1 to FFF is assigned to each interface. The interfaces on each ring (segment) have the same segment number, but the segment number is unique to each ring.

These prompts appear for each Token Ring interface.

```
Interface 1 (Port 2) is of type Token Ring
Configure Source Routing on this interface? (Yes, No): [Yes]
Configuring Interface 1 (Port 2)
Segment Number (hex) of this Interface (1-FFF): [A2]
```

If more than two interfaces are configured for source routing, enter a unique hexadecimal value from 1 to FFF unique for the internal virtual segment.

```
Virtual Segment Number (hex) of this Router (1-FFF): [A4]
```

5. A panel similar to the following is displayed:

```
This is all configured bridging information:

Interfaces configured for STB:

Interface #   Port #   Interface Type
-----
0            1       Token Ring
1            2       Token Ring

The Source Routing part of SRT Bridging has been enabled

Bridge Number of this Router: A

Interfaces configured for Source Routing:

Interface #   Port#   Segment #   Interface Type
-----
0            1       A1         Token Ring
1            2       A2         Token Ring

Virtual Segment Number of this Router: A4

Save this Configuration? (Yes, No): [Yes]
```

6. Enter **y** to save the bridging configuration and continue with quick configuration. Enter **n** to re-display the bridging configuration prompts.

If you enter **y**, the following message appears:

```
Bridging configuration saved
```

---

## Configuring Protocols

After you save the bridging configuration, you will see the following panel:

```
*****
Protocol Configuration
*****

Type 'Yes' to Configure Protocols
Type 'No' to skip Protocol Configuration
Type 'Quit' to exit Quick Config

Configure Protocols? (Yes, No, Quit): [Yes]
```

Take one of the following actions:

- Enter **y** to configure the protocols.
- Enter **n** to skip protocol configuration and continue with quick configuration.
- Enter **q** to exit quick configuration.

You will first configure IP, then IPX, and then DECnet.

## Configuring IP

When you answer **y** to the Configure Protocol panel, quick configuration displays the following messages:

```
Type 'r' any time at this level to restart Protocol configuration
Configure IP? (Yes, No): [Yes]
```

1. Take one of the following actions:

- Enter **y** to configure IP.
- Enter **n** to skip IP configuration and continue with quick configuration.

The following lines appear for each interface.

```
Configuring Per-Interface IP Information
Type 'Yes' to Configure IP on this interface
Type 'No' to skip to the next interface
Type '?' to list interfaces
Type an interface # to skip to that interface
Type 'Quit' to exit Per-Interface IP Configuration

Configure IP on Interface 0 (Token Ring)?
(Yes, No, #, ?, Quit) [Yes]
IP Address: [] 128.185.141.1
Address Mask: [255.255.0.0]
```

2. Enter the IP address in decimal notation for example, 128.185.142.20. The console displays one of the following error messages if you enter an invalid IP address:

```
Bad address, please try again.
```

```
This address has already been assigned. Enter a different address
```

Address mask is a decimal value that reflects the IP network or subnetwork to which this interface is attached.

For more information about IP addressing or address masks, refer to the *Protocol Configuration and Monitoring Reference*, or consult your network administrator.

```
Per-Interface IP Configuration complete
Configuring IP Routing Information
Enable Dynamic Routing (Yes, No): [Yes]
```

3. Enter **y** if you want the routing protocols (RIP or OSPF) to build the routing tables. Enter **n** to manually add IP address destinations to the routing tables (static routes).

```
Enable OSPF? (Yes, No): [Yes]
```

4. Enter **y** to enable the OSPF routing protocol as the primary dynamic IP routing protocol. RIP will be enabled only to send advertisements, not to receive them. Enter **n** if you do not want to use OSPF. RIP will be enabled to send and receive advertisements.

```
OSPF Enabled with Max routes = 1000 and Max routers = 50
```

Max routes is the maximum number of autonomous system (AS) external routes imported into the OSPF routing domain. Max routers is the maximum number of OSPF routers in the routing domain.

```
Routing Configuration Complete

SNMP will be configured with the following parameters:

Community: public
Access: READONLY

If you plan to use the graphical configuration tool
to download a configuration, it requires the definition
of a community name with read_write_trap access.

Define community with read_write_trap access ? (Yes, No): [Yes]

This is the information you have entered:

      Interface #      IP Address      Address Mask
          0           128.185.141.1  255.255.255.0
          1           128.185.142.1  255.255.255.0
          2           128.185.143.1  255.255.255.0

OSPF is configured, and RIP is configured only for 'sending'

SNMP has been configured with the following parameters:

Community: public
Access: read_trap

Community: dana
Access: read_write_trap

Save this configuration? (Yes, No): [Yes]
```

5. Enter **y** to save the IP configuration and continue with quick configuration. Enter **n** to re-display the protocol configuration prompts.

## Configuring IPX

After you save the IP configuration, you will see the following messages:

```
Configure IPX? (Yes, No): [Yes]
```

1. Enter **y** to configure IPX. Enter **n** to skip IPX configuration and continue with quick configuration.

You will see messages similar to the following:

```
Type 'r' any time at this level to restart IPX Configuration
IPX Configuration is already present
Configure IPX anyway? (Yes, No): [No] yes
```

2. Enter **y** to replace the existing configuration. Enter **n** to keep the current configuration and continue.

#### Configuring Per-Interface IPX Information

Type 'Yes' to Configure IPX on this interface  
Type 'No' to skip to the next interface  
Type an interface # to skip to that interface  
Type '?' to list interfaces  
Type 'Quit' to exit Per-Interface IPX Configuration

Configure IPX on Interface 0 (Token Ring)?  
(Yes, No, #, ?, Quit) [Yes]

3. The next messages and your responses depend on whether you are configuring Token-Ring, FDDI, or Ethernet.

#### Configuring Interface 0 (Token Ring):

- a. The following prompt is displayed:

```
Token Ring encapsulation (frame) type? (TOKEN-RING MSB, TOKEN-RING LSB,  
TOKEN-RING_SNAP MSB, TOKEN-RING_SNAP LSB): [TOKEN-RING MSB]
```

- b. Enter the encapsulation type used by the IPX protocol on your Token-Ring end stations.

Token-Ring MSB:	Most common encapsulation type and the default. The IBM 2216 builds outgoing packets with a 3-byte 802.2 header, (0xE0, 0xE0, 0x03). It sends the source and destination addresses in MSB (most significant bit), or noncanonical, format, which is the native address format for Token-Ring.
Token-Ring LSB	Same as Token-Ring MSB except the IBM 2216 sends the addresses in LSB (least significant bit), or canonical, format.
Token-Ring SNAP MSB	The IBM 2216 builds outgoing packets with an 8-byte 802.2/SNAP header (0xAA, 0xAA, 0x03, 0x00, 0x00, 0x00, 0x81, 0x37). It sends the source and destination addresses in most significant bit (MSB), or noncanonical, format.
Token-Ring SNAP LSB	Same as Token-Ring SNAP MSB except the IBM 2216 sends the addresses in LSB, or canonical, format.

#### Configuring IPX for Ethernet:

- a. The following prompts are displayed:

```
Ethernet encapsulation type? (ETHERNET_8022, ETHERNET_8023, ETHERNET_II,  
ETHERNET_SNAP): [ETHERNET_8023]
```

- b. Enter the encapsulation type used by the IPX protocol on your Ethernet end stations.

Ethernet_8022	Packet includes an 802.2 header.
Ethernet_8023	Uses an IEEE 802.3 packet format without the 802.2 header. This is the default and the default for NetWare versions prior to 4.0. Ethernet 802.3 does not conform to the IEEE 802 standards because it does not include an 802.2 header. It may cause problems with other nodes on the network.
Ethernet_II	Uses Ethernet type 8137 as the packet format. This format is required if you are using NetWare VMS on the Ethernet. This is the default for NetWare Versions 4.0 and higher.

Ethernet\_SNAP            Uses the 802.2 format with a SNAP header. This encapsulation type is meant to be compatible with token-ring SNAP encapsulation. However, it violates IEEE standards and is not interoperable across conformal bridges.

### Configuring IPX for FDDI:

- a. The following prompts are displayed:

```
FDDI encapsulation (frame) type? (FDDI, FDDI_SNAP): [FDDI_SNAP]
```

- b. Enter the encapsulation type used by the IPX Protocol for your FDDI end stations.

fddi                      Sets the encapsulation type to FDDI IEEE 802.2.

fddi\_snap                Sets the encapsulation type to FDDI SNAP.

```
Network Number (hex) (1-FFFFFFFD):[1] 1
```

4. Assign an IPX network number to the associated directly connected network. Every IPX interface must have a unique network number.

```
Configure IPX on Interface 1 (WAN PPP)
(Yes, No, #, ?, Quit) [Yes]
Network Number (hex) (1-FFFFFFFD): [1] 2

Enable IPXWAN? (Yes, No): [No] yes

Configure IPS on Interface 2 (WAN PPP)
(Yes, No, #, ?, Quit) [Yes]
Network Number (hex) (1-FFFFFFFD):[1] 3

Enable IPXWAN? (Yes, No): [No] yes

Host Number for Serial Lines: (000000000000) 1

Configure IPXWAN NodeID? (Yes, No): [Yes]
NodeID (hex) (1 - FFFFFFFD): [1] 4
```

If enabled, the IPXWAN protocol negotiates routing parameters to be used on the PPP serial interface before IPX packet forwarding begins. IPXWAN is not required to forward IPX packets on PPP serial interfaces. The IPXWAN Node ID is a unique IPX network number that identifies the router, and is required if IPXWAN is enabled on any network interfaces.

5. Host number is a unique 12-digit hexadecimal value assigned to an IPX router. It is required because serial lines do not have hardware node addresses from which to build a host number.



This is the information you have entered:

Per-Interface Configuration Information

Cir	Ifc	IPX Net(hex)	Encapsulation	IPXWAN
1	1	10	ETHERNET_8023	Not Configured
2	3	300		Not Configured
3	5	400		Not Configured
4	6	600		Enabled

Host Number for Serial Lines: 0002210A0000  
IPXWAN Node ID = 2210A  
IPX Router Name = ipxwan\_router-2210A

Save this configuration? (Yes, No): [Yes]

6. Enter **y** to save the IPX configuration and continue with quick configuration. Enter **n** to re-display the IPX configuration prompts.

If you enter **y**, the following message appears:

IPX configuration saved

## Configuring DECnet (DNA)

After you save the IPX configuration, you will see the following messages.

IPX Configuration saved

Configure DNA? (Yes, No): [Yes]

1. Enter **y** to configure DNA. Enter **n** to skip DNA configuration and continue with quick configuration.

Type 'r' any time at this level to restart DNA Configuration

Configuring Global DNA information

Highest Node Number (decimal) (1-1023): [32]  
Router Level (Level1, Level2, DEC Level1, DEC Level2):  
[ Level2]  
Highest Area (decimal) (1-63): [63]  
Node Address (area.node): (63.32)

The above configuration fields are configured with the following considerations:

### Highest Node Number

Is the highest node address in the router's area. Setting it excessively high will affect the routers efficiency and require excess storage.

### Router Level

Identifies whether the router is a Level 1 or Level 2 router. A Level 1 router keeps track of all nodes in its area and does not care about nodes outside its area. A Level 2 router routes traffic between areas.

Normally you should select Level1 or Level2 with the following exception: select DEC Level1 or DEC Level2 only when this router must communicate over X.25 networks with routers conforming to the DEC X.25 standard.

### Highest Area

This number should be at least as high as the highest area number in the overall network.

## Node Address

Is the node ID of this router and must be unique in the network.

When you press Enter, the following is displayed:

```
Configuring Per-Interface DNA Information
Configuring Max Routers on each interface

Configuring Interface 0 (Ethernet)
Configure DNA on this interface? (Yes, No) [YES]
Max Routers (decimal) (1-33): [16]

Configuring Interface 1 (WAN PPP)
Configure DNA on this interface? (Yes, No) [Yes]

Configuring Interface 2 (Token Ring)
Configure DNA on this interface? (Yes, No) [Yes]
Max Routers (decimal) (1-33): [16]
```

2. Enter **y** for every interface that will be connected to the DECnet network. For LANs, Max Routers specifies how many other routers may be on this circuit. For router efficiency and memory requirements set this argument to a few more than the total number of adjacent routers on this circuit.

The following panel is displayed:

```
This is the information you have entered:

Global Configuration Information

Highest Node Number:      32
Router Level:             Level2
Highest Area:             63
Node Address:             63.32

Pre-Interface Configuration Information
Interface Number          Max Routers

      0                    16
      1                    1
      2                    16

Save this configuration? (Yes, No): [Yes]
```

3. Enter **y** to save the DECnet configuration and continue with the quick configuration. Enter **n** to re-display the DECnet configuration prompts.

If you enter **y**, the following message appears:

```
DNA Configuration Saved
```

---

## Reloading the Device

After configuring the protocols, you will receive the following message:

```
Quick Config Done
Do you want to write this configuration? (Yes, No): [Yes]
```

Enter **y** to save your changes and display the following information:

Default config file written successfully.

Configuration was written.  
The system must be restarted for this configuration to take effect.

Enter **reload** at the OPCON prompt (\*) to reload the device with the new configuration. To change or view the current configuration, enter **qc**.



---

## Appendix B. X.25 National Personalities

This appendix lists the default settings for GTE-Telenet and DDN.

---

### GTE-Telenet

The following parameters are the default settings for GTE-Telenet:

- Callreq: 20
- Clearreq:
  - Retries: 1
  - Timer: 18
- Disconnect: Passive
- DP-timer: 500 milliseconds
- Frame window size: 7
- Network Type: CCITT
- N2 timeouts: 20
- Packet:
  - Default size: 128
  - Maximum size: 256
  - Window size: 2
- Reset
  - Retries: 1
  - Timer: 18
- Restart
  - Retries: 1
  - Timer: 18
- Standard: 1984
- T1-timer: 4
- T2-timer: 2

---

### DDN

The following parameters are the default settings for DDN:

- Callreq: 20
- Clearreq:
  - Retries: 1
  - Timer: 18
- Disconnect: Passive
- DP-timer: 500 milliseconds
- Frame window size: 7
- Network Type: CCITT
- N2 timeouts: 20
- Packet:
  - Default size: 128
  - Maximum size: 256
  - Window size: 2
- Reset
  - Retries: 1
  - Timer: 18

- Restart
  - Retries: 1
  - Timer: 18
- Standard: 1984
- T1-timer: 4
- T2-timer: 2

---

## Appendix C. Making a Router Load File from Multiple Disks

If a software load arrives on multiple disks, use the procedure in the following sections to combine the loads into one load file that the router can use at the time of booting.

The first disk contains the following four files that you need if you want to fragment an existing load for transport on multiple diskettes.

### **cutup.c**

(UNIX C source file that can be compiled using a standard C compiler)

### **cutup.exe**

(DOS)

Use the following files for reassembling the load fragments onto a DOS or UNIX server.

### **kopy.bat**

(DOS)

**kopy** (UNIX shell script)

---

## Assembling a Load File Under DOS

To assemble a load from the two diskettes, use the DOS batch file provided on diskette 1 (KOPY.BAT) using the following syntax:

```
kopy <installation_drive><destination_directory>
```

Before assembling the load make sure that you have created a destination directory, and that you have inserted the first diskette in the drive specified by the installation\_diskette\_drive parameter. The following example illustrates this procedure.

```
B:\>kopy b: c:\source\cutup\tmp
B:\>copy c:\gw0/B c:\source\cutup\tmp\gw.tmp
1 file(s) copied
.
Please mount the second diskette
Press any key to continue . . .
Copying the second load file fragment
B:\>
B:\>copy c:\source\cutup\tmp\gw.tmp/B + b:\gw1
c:\source\cutup\tmp\gw.tmp c:\SOURCE\CUTUP\TMP\GW.TMP
B:\GW1
1 file(s) copied
B:\>rename c:\source\cutup\tmp\gw.tmp gw.ldc
Load file reassembly was successful
B:>
```

---

## Assembling a Load File Under UNIX

To assemble a load from two UNIX diskettes, you can use the UNIX Bourne shell script (kopy) provided on diskette 1 using the following syntax:

```
kopy<installation_drive><diskette_directory><destination_directory>
```

Before assembling the load make sure that you have created the mount and destination directories, and that you have inserted the first diskette in the drive specified by the installation\_diskette\_drive parameter. The following example illustrates this procedure.

```
kopy /dev/fd0 /kew /pcfs
```

Please insert the first diskette

Copying the first load file fragment

Please mount the second diskette

Copying the second load file fragment

Load file reassembly was successful

```
# 1s /kew
```

```
gw0 gw1 gw.ldc
```

If you can't use the UNIX Bourne shell script, you can assemble the load manually using the following procedure:

1. Copy the load fragments on the two diskettes (gw0 and gw1) into a directory on the UNIX file system.
2. Type the following UNIX command:

```
cat gw0 gw1 > gw.ldc
```

The resulting file (gw.ldc) is the assembled router load.

---

## Disassembling a Load File Under DOS

To disassemble a load under DOS, use the CUTUP.EXE file as follows:

```
cutup<file_extension><file_name><cut_length>
```

The file\_extension is attached to the front of each slice needed to cut. The file\_name is the DOS file name of the file to be disassembled. The cut\_length is the length that CUTUP.EXE makes each fragment as it disassembles the file. The following example illustrates this procedure.

```
C: \source\cutup>dir
Volume in drive C has no label
Volume Serial Number is XXXXXXXX
Directory of C: \SOURCE\CUTUP
.0730934:46p
..0730934:46p
GW      LDC 10225660728931:22p
CUTUP   EXE 105410902939:38a
2 file(s) 1033107 bytes
14811136 bytes free
C: \source\cutup>cutup gw.ldc gw 1000000
.....
.....
.....
c: \SOURCE\CUTUP>dir
Volume in drive C has no label
Volume Serial Number is XXXXXXXX
Directory of C: \SOURCE\CUTUP
.0730934:46p
..0730934:46p
GW      0 10000000801931:22p
GW      LDC 10225660728931:22p
CUTUP   EXE 105410902939:38a
GW      1 225660801931:22p
4 file(s) 2055673 bytes
14811136 bytes free
```

---

## Disassembling a Load File Under UNIX

To disassemble a load under use cutup.c. Begin by compiling the program using your UNIX compiler to make a cutup executable file. Then use the following syntax:

```
cutup<file_extension><file_name><cut_length>
```



The file\_extension is attached to the front of each slice needed to cut. The file\_name is the DOS file name of the file to be disassembled. The cut\_length is the length CUTUP.EXE that is used to disassemble the file. The following example illustrates this procedure.

```
# ls -la
total 658
drwxrwxr-x 2 root 512 Aug 114:41 .
drwxrwxr-x 26 root 1024 Aug 114:41 ..
drwxrwxr-x 2 root 24576 Aug 114:41 cutup
drwxrwxr-x 2 root1022566 Aug 114:41 gw.ldc

# cutup gw.ldc gw 100000

# ls -la
total 658
drwxrwxr-x 2 root 512 Aug 114:41 .
drwxrwxr-x 26 root 1024 Aug 114:41 ..
drwxrwxr-x 2 root 24576 Aug 114:41 cutup
drwxrwxr-x 2 root1022566 Aug 114:41 gw.ldc
drwxrwxr-x 2 root1000000 Aug 114:41 gw0
drwxrwxr-x 2 root 22566 Aug 114:41 gw1
```



---

## Appendix D. Remote AAA Attributes

This section identifies the remote AAA Attributes used by Radius, TACACS and TACACS+ servers.

---

### Radius

IBM Vendor ID: 211

#### Authorization Attributes

##### Standard Drafted

TUNNEL_TYPE	64
TUNNEL_MEDIUM_TYPE	65
TUNNEL_CLIEN_TYPE	66
TUNNEL_SERVER_EP	67
TUNNEL_CONN_ID	68
TUNNEL_PASSWORD	69

values

TUNNEL_TYPE		integer
1	PPTP	
2	L2F	
3	L2TP	
TUNNEL_MEDIUM_TYPE		integer
1	IP	
TUNNEL_SERVER_EP		string
	ip address	

##### IBM Vendor Specific

NAS_TUNNEL_PASSWORD	101
INBYTES_AH	110
INBYTES_ESP	111
OUTBYTES_AH	112
OUTBYTES_ESP	113
INPKTS_BAD	114
OUTPKTS_BAD	115
INPKTS_BAD_AH	116
INPKTS_BAD_ESP	117
OUTPKTS_BAD_AH	118
OUTPKTS_BAD_ESP	119
INPKTS_AH	120
AH INPKTS_ESP	121
OUTPKTS_AH	122
AH OUTPKTS_ESP	123
INPKTS_BAD_AH_RPLY	124

INPKTS_BAD_ESP_RPLY	125
INBYTES_WRAP	128
OUTBYTES_WRAP	129
INB_AH_WRAP	130
INB_ESP_WRAP	131
OUB_AH_WRAP	132
OUB_ESP_WRAP	133
POLICY_NAME	135
P1_ID	136
TRANSFORMS	137
REFR_CNT	138
COMPR	139
ESP_ALGO	140
AH_ALGO	141
ESPAUTH_ALGO	142
P1_NAME	143
VC-ACTIVE	177
VC-IDLETIME	179
VC-SUSPENDTIME	180
CALLBACK_FLAGS	210
ENCRYPTION	211
HOSTNAME	213
SUBNETMASK	215
PRIVILEGE	216

## Keywords

Keywords are used for Radius servers that allow the entry of vendor specific fields  
<keyword>=<value>.

KWD_VC_ACTIVE	VCN
KWD_VC_IDLETIME	VCI
KWD_VC_SUSPENDTIME	VCS
KWD_CALLBACK_FLAGS	CBF
KWD_ENCRYPTION	ENC
KWD_HOSTNAME	HSN
KWD_SUBNETMASK	SNM
KWD_PRIVILEGE	PRV

Values

CALLBACK_FLAGS	
REQ	required callback
ROAM	roaming callback

PRIVILEGE:

    ADMIN  
    OPER  
    MONITOR

## Example of RADIUS Configuration File

The following is an example of a RADIUS configuration file:

```
VENDOR IBM 211
ATTRIBUTE      User-Name          1          string
ATTRIBUTE      User-Password      2          string
ATTRIBUTE      CHAP-Password      3          string
ATTRIBUTE      NAS-IP-Address     4          ipaddr
ATTRIBUTE      NAS-Port           5          integer
ATTRIBUTE      Service-Type       6          integer
ATTRIBUTE      Framed-Protocol    7          integer
ATTRIBUTE      Framed-IP-Address  8          ipaddr
ATTRIBUTE      Framed-IP-Netmask  9          ipaddr
ATTRIBUTE      Framed-Routing     10         integer
ATTRIBUTE      Filter-Id          11         string
ATTRIBUTE      Framed-MTU         12         integer
ATTRIBUTE      Framed-Compression 13         integer
ATTRIBUTE      Login-IP-Host      14         ipaddr
ATTRIBUTE      Login-Service      15         integer
ATTRIBUTE      Login-TCP-Port     16         integer #
ATTRIBUTE      Old-Password       17         string
ATTRIBUTE      Reply-Message      18         string
ATTRIBUTE      Callback-Number    19         string
ATTRIBUTE      Callback-Id        20         string #
ATTRIBUTE      Unassigned         21         string
ATTRIBUTE      Framed-Route       22         string
ATTRIBUTE      Framed-IPX-Network 23         integer
ATTRIBUTE      State              24         string
ATTRIBUTE      Class              25         string
ATTRIBUTE      Vendor-Specific    26         string
ATTRIBUTE      Session-Timeout    27         integer
ATTRIBUTE      Idle-Timeout       28         integer
ATTRIBUTE      Termination-Action 29         integer
ATTRIBUTE      Called-Station-Id  30         string
ATTRIBUTE      Calling-Station-Id 31         string
ATTRIBUTE      NAS-Identifier      32         string
ATTRIBUTE      Proxy-State        33         string
ATTRIBUTE      Login-LAT-Service  34         string
ATTRIBUTE      Login-LAT-Node     35         string
ATTRIBUTE      Login-LAT-Group    36         string
ATTRIBUTE      Framed-Appletalk-Link 37         integer
ATTRIBUTE      Framed-Appletalk-Net 38         integer
ATTRIBUTE      Framed-Appletalk-Zone 39         string
ATTRIBUTE      Acct-Status-Type   40         integer
ATTRIBUTE      Acct-Delay-Time    41         integer
ATTRIBUTE      Acct-Input-Octets  42         integer
ATTRIBUTE      Acct-Output-Octets 43         integer
ATTRIBUTE      Acct-Session-Id    44         string
ATTRIBUTE      Acct-Authentic     45         integer
ATTRIBUTE      Acct-Session-Time  46         integer
ATTRIBUTE      Acct-Input-Packets 47         integer
ATTRIBUTE      Acct-Output-Packets 48         integer
ATTRIBUTE      Acct-Terminate-Cause 49         integer
ATTRIBUTE      Acct-Multi-Session-Id 50         string
ATTRIBUTE      Acct-Link-Count    51         integer
```

ATTRIBUTE	CHAP-Challenge	60	string
ATTRIBUTE	NAS-Port-Type	61	integer
ATTRIBUTE	Port-Limit	62	integer
ATTRIBUTE	Login-LAT-Port	63	string
----- START IBM -----			
ATTRIBUTE	Tunnel-Type	64	integer
ATTRIBUTE	Tunnel-Medium	65	integer
ATTRIBUTE	Tunnel-Client-EP	66	string
ATTRIBUTE	Tunnel-Server-EP	67	string
ATTRIBUTE	Tunnel-Conn-ID	68	string
ATTRIBUTE	Tunnel-Password	69	string
ATTRIBUTE	Tunnel-NAS-Password	101	string
ATTRIBUTE	VC-ACTIVE	177	integer
ATTRIBUTE	VC-IDLETIME	179	integer
ATTRIBUTE	VC-SUSPENDTIME	180	integer
ATTRIBUTE	IBM-Callback-Flags	210	string
ATTRIBUTE	IBM-Encryption	211	string
ATTRIBUTE	IBM-DialOut	214	string
ATTRIBUTE	IBM-Hostname	213	string
ATTRIBUTE	IBM-Subnetmask	215	string
ATTRIBUTE	IBM-Privilege	216	string
ATTRIBUTE	IBM-ipsec-inb-ah	110	integer
ATTRIBUTE	IBM-ipsec-inb-esp	111	integer
ATTRIBUTE	IBM-ipsec-ob-ah	112	integer
ATTRIBUTE	IBM-ipsec-ob-esp	113	integer
ATTRIBUTE	IBM-ipsec-ip-bad	114	integer
ATTRIBUTE	IBM-ipsec-op-bad	115	integer
ATTRIBUTE	IBM-ipsec-ip-bad-ah	116	integer
ATTRIBUTE	IBM-ipsec-ip-bad-esp	117	integer
ATTRIBUTE	IBM-ipsec-op-bad-ah	118	integer
ATTRIBUTE	IBM-ipsec-op-bad-esp	119	integer
ATTRIBUTE	IBM-ipsec-ip-ah	120	integer
ATTRIBUTE	IBM-ipsec-ip-esp	121	integer
ATTRIBUTE	IBM-ipsec-op-ah	122	integer
ATTRIBUTE	IBM-ipsec-op-esp	123	integer
ATTRIBUTE	IBM-ipsec-ip-bad-ah-r	124	integer
ATTRIBUTE	IBM-ipsec-ip-bad-esp-r	125	integer
ATTRIBUTE	IBM-ipsec-inb-wrap	128	integer
ATTRIBUTE	IBM-ipsec-ob-wrap	129	integer
ATTRIBUTE	IBM-ipsec-ib-ah-wrap	130	integer
ATTRIBUTE	IBM-ipsec-ib-esp-wrap	131	integer
ATTRIBUTE	IBM-ipsec-ob-ah-wrap	132	integer
ATTRIBUTE	IBM-ipsec-ob-esp-wrap	133	integer
ATTRIBUTE	IBM-ipsec-policy-name	135	string
ATTRIBUTE	IBM-ipsec-p1-id	136	string
ATTRIBUTE	IBM-ipsec-p1-name	143	string
ATTRIBUTE	IBM-ipsec-esp-algo	140	string
ATTRIBUTE	IBM-ipsec-ah-algo	141	string
ATTRIBUTE	IBM-ipsec-esp-algo	142	string
VALUE	Tunnel-Type	L2TP	3
VALUE	Tunnel-Type	L2F	2
VALUE	Tunnel-Type	PPTP	1
VALUE	Tunnel-Medium	IP	1
VALUE	VC-ACTIVE	YES	1

VALUE	VC-ACTIVE	NO	0
VALUE	IBM-Callback-Flags	Required	REQ
VALUE	IBM-Callback-Flags	Roaming	OAM
VALUE	IBM-Dialout	Enable	TRUE
VALUE	IBM-Dialout	Disable	FALSE
VALUE	IBM-Dialout	ONLY	ONLY
VALUE	IBM-Privilege	Administrator	ADMIN
VALUE	IBM-Privilege	Operator	OPER
VALUE	IBM-Privilege	Monitor	MONITOR

---

## TACACS+

### Authentication

### Authorization

PPP service=ppp protocol=ip  
 LOGIN service=shell cmd=null pri\_lvl\*0

#### Standard TACACS+ Attributes

service  
 protocol  
 cmd  
 addr  
 timeout  
 priv\_lvl 0 (monitor privilege), 1 (operator privilege), 15 (administrator privilege)  
 callback-dialstring

#### IBM Specific Attributes

encryption\_key 16 hex characters  
 dial\_out TRUE FALSE ONLY

### Accounting

task\_id  
 start\_time  
 stop\_time  
 elapsed\_time  
 timezone  
 event  
 reason  
 bytes  
 bytes\_in  
 bytes\_out  
 paks  
 paks\_in  
 paks\_out  
 status  
 err\_msg





---

## List of Abbreviations

<b>AARP</b>	AppleTalk Address Resolution Protocol
<b>ABR</b>	area border router
<b>ack</b>	acknowledgment
<b>AIX</b>	Advanced Interactive Executive
<b>AMA</b>	arbitrary MAC addressing
<b>AMP</b>	active monitor present
<b>ANSI</b>	American National Standards Institute
<b>AP2</b>	AppleTalk Phase 2
<b>APPN</b>	Advanced Peer-to-Peer Networking
<b>ARE</b>	all-routes explorer
<b>ARI</b>	ATM real interface
<b>ARI/FCI</b>	address recognized indicator/frame copied indicator
<b>ARP</b>	Address Resolution Protocol
<b>AS</b>	autonomous system
<b>ASBR</b>	autonomous system boundary router
<b>ASCII</b>	American National Standard Code for Information Interchange
<b>ASN.1</b>	abstract syntax notation 1
<b>ASRT</b>	adaptive source routing transparent
<b>ASYNC</b>	asynchronous
<b>ATCP</b>	AppleTalk Control Protocol
<b>ATP</b>	AppleTalk Transaction Protocol
<b>AUI</b>	attachment unit interface
<b>AVI</b>	ATM virtual interface
<b>ayt</b>	are you there
<b>BAN</b>	Boundary Access Node
<b>BBCM</b>	Bridging Broadcast Manager
<b>BECN</b>	backward explicit congestion notification
<b>BGP</b>	Border Gateway Protocol
<b>BNC</b>	bayonet Niell-Concelman
<b>BNCP</b>	Bridging Network Control Protocol
<b>BOOTP</b>	BOOT protocol
<b>BPDU</b>	bridge protocol data unit
<b>bps</b>	bits per second
<b>BR</b>	bridging/routing

**BRS** bandwidth reservation  
**BSD** Berkeley software distribution  
**BTP** BOOTP relay agent  
**BTU** basic transmission unit  
**CAM** content-addressable memory  
**CCITT** Consultative Committee on International Telegraph and Telephone  
**CD** collision detection  
**CGWCON**  
     Gateway Console  
**CIDR** Classless Inter-Domain Routing  
**CIP** Classical IP  
**CIR** committed information rate  
**CLNP** Connectionless-Mode Network Protocol  
**CPU** central processing unit  
**CRC** cyclic redundancy check  
**CRS** configuration report server  
**CTS** clear to send  
**CUD** call user data  
**DAF** destination address filtering  
**DB** database  
**DBsum**  
     database summary  
**DCD** data channel received line signal detector  
**DCE** data circuit-terminating equipment  
**DCS** Directly connected server  
**DDLC** dual data-link controller  
**DDN** Defense Data Network  
**DDP** Datagram Delivery Protocol  
**DDT** Dynamic Debugging Tool  
**DHCP** Dynamic Host Configuration Protocol  
**dir** directly connected  
**DL** data link  
**DLC** data link control  
**DLCI** data link connection identifier  
**DLS** data link switching  
**DLSw** data link switching  
**DMA** direct memory access  
**DNA** Digital Network Architecture

**DNCP** DECnet Protocol Control Protocol  
**DNIC** Data Network Identifier Code  
**DoD** Department of Defense  
**DOS** Disk Operating System  
**DR** designated router  
**DRAM** Dynamic Random Access Memory  
**DSAP** destination service access point  
**DSE** data switching equipment  
**DSE** data switching exchange  
**DSR** data set ready  
**DSU** data service unit  
**DTE** data terminal equipment  
**DTR** data terminal ready  
**Dtype** destination type  
**DVMRP**  
     Distance Vector Multicast Routing Protocol  
**E&M** Ear & Mouth  
**E1** 2.048 Mbps transmission rate  
**EDEL** end delimiter  
**EDI** error detected indicator  
**EGP** Exterior Gateway Protocol  
**EIA** Electronics Industries Association  
**ELAN** Emulated LAN  
**ELAP** EtherTalk Link Access Protocol  
**ELS** Event Logging System  
**ELSCon**  
     Secondary ELS Console  
**ESI** End system identifier  
**EST** Eastern Standard Time  
**Eth** Ethernet  
**fa-ga** functional address-group address  
**FCS** frame check sequence  
**FECN** forward explicit congestion notification  
**FIFO** first in, first out  
**FLT** filter library  
**FR** Frame Relay  
**FRL** Frame Relay  
**FTP** File Transfer Protocol

<b>FXO</b>	Foreign Exchange Office
<b>FXS</b>	Foreign Exchange Station
<b>GMT</b>	Greenwich Mean Time
<b>GOSIP</b>	Government Open Systems Interconnection Profile
<b>GTE</b>	General Telephone Company
<b>GWCON</b>	Gateway Console
<b>HDLC</b>	high-level data link control
<b>HEX</b>	hexadecimal
<b>HPR</b>	high-performance routing
<b>HST</b>	TCP/IP host services
<b>HTF</b>	host table format
<b>IBD</b>	Integrated Boot Device
<b>ICMP</b>	Internet Control Message Protocol
<b>ICP</b>	Internet Control Protocol
<b>ID</b>	identification
<b>IDP</b>	Initial Domain Part
<b>IDP</b>	Internet Datagram Protocol
<b>IEEE</b>	Institute of Electrical and Electronics Engineers
<b>Ifc#</b>	interface number
<b>IGP</b>	interior gateway protocol
<b>InARP</b>	Inverse Address Resolution Protocol
<b>IP</b>	Internet Protocol
<b>IPCP</b>	IP Control Protocol
<b>IPPN</b>	IP Protocol Network
<b>IPX</b>	Internetwork Packet Exchange
<b>IPXCP</b>	IPX Control Protocol
<b>ISDN</b>	integrated services digital network
<b>ISO</b>	International Organization for Standardization
<b>Kbps</b>	kilobits per second
<b>LAC</b>	L2TP Network Access Concentrator
<b>LAN</b>	local area network
<b>LAPB</b>	link access protocol-balanced
<b>LAT</b>	local area transport
<b>LCS</b>	LAN Channel Station
<b>LCP</b>	Link Control Protocol
<b>LED</b>	light-emitting diode

<b>LF</b>	largest frame; line feed
<b>LIS</b>	Logical IP subnet
<b>LLC</b>	logical link control
<b>LLC2</b>	logical link control 2
<b>LMI</b>	local management interface
<b>LNS</b>	L2TP Network Server
<b>LRM</b>	LAN reporting mechanism
<b>LS</b>	link state
<b>LSA</b>	link state advertisement
<b>LSA</b>	Link Services Architecture
<b>LSB</b>	least significant bit
<b>LSI</b>	LAN shortcuts interface
<b>LSreq</b>	link state request
<b>LSrxl</b>	link state retransmission list
<b>LU</b>	logical unit
<b>MAC</b>	medium access control
<b>Mb</b>	megabit
<b>MB</b>	megabyte
<b>Mbps</b>	megabits per second
<b>MBps</b>	megabytes per second
<b>MC</b>	multicast
<b>MCF</b>	MAC filtering
<b>MIB</b>	Management Information Base
<b>MIB II</b>	Management Information Base II
<b>MILNET</b>	military network
<b>MOS</b>	Micro Operating System
<b>MOSDBG</b>	Micro Operating System Debugging Tool
<b>MOSPF</b>	Open Shortest Path First with multicast extensions
<b>MPC</b>	Multi-Path Channel
<b>MPC+</b>	High performance data transfer (HPDT) Multi-Path Channel
<b>MSB</b>	most significant bit
<b>MSDU</b>	MAC service data unit
<b>MRU</b>	maximum receive unit
<b>MTU</b>	maximum transmission unit
<b>nak</b>	not acknowledged

**NAS** Nways Switch Administration station

**NBMA** Non-Broadcast Multiple Access

**NBP** Name Binding Protocol

**NBR** neighbor

**NCP** Network Control Protocol

**NCP** Network Core Protocol

**NDPS** non-disruptive path switching

**NetBIOS**  
Network Basic Input/Output System

**NHRP** Next Hop Resolution Protocol

**NIST** National Institute of Standards and Technology

**NPDU** Network Protocol Data Unit

**NRZ** non-return-to-zero

**NRZI** non-return-to-zero inverted

**NSAP** Network Service Access Point

**NSF** National Science Foundation

**NSFNET**  
National Science Foundation NETwork

**NVCNFG**  
nonvolatile configuration

**OOS** Out of Service

**OPCON**  
Operator Console

**OSI** open systems interconnection

**OSICP**  
OSI Control Protocol

**OSPF** Open Shortest Path First

**OUI** organization unique identifier

**PC** personal computer

**PCA** parallel channel adapter

**PCR** peak cell rate

**PDN** public data network

**PING** Packet internet groper

**PDU** protocol data unit

**PID** process identification

**P-P** Point-to-Point

**PPP** Point-to-Point Protocol

**PROM** programmable read-only memory

**PU** physical unit

**PVC** permanent virtual circuit  
**RAM** random access memory  
**RD** route descriptor  
**REM** ring error monitor  
**REV** receive  
**RFC** Request for Comments  
**RI** ring indicator; routing information  
**RIF** routing information field  
**RII** routing information indicator  
**RIP** Routing Information Protocol  
**RISC** reduced instruction-set computer  
**RNR** receive not ready  
**ROM** read-only memory  
**ROpcon**  
     Remote Operator Console  
**RPS** ring parameter server  
**RTMP** Routing Table Maintenance Protocol  
**RTP** RouTing update Protocol  
**RTS** request to send  
**Rtype** route type  
**rxmits** retransmissions  
**rxmt** retransmit  
**s** second  
**SAF** source address filtering  
**SAP** service access point  
**SAP** Service Advertising Protocol  
**SCR** Sustained cell rate  
**SCSP** Server Cache Synchronization Protocol  
**sdel** start delimiter  
**SDLC** SDLC relay, synchronous data link control  
**seqno** sequence number  
**SGID** sever group id  
**SGMP** Simple Gateway Monitoring Protocol  
**SL** serial line  
**SMP** standby monitor present  
**SMTP** Simple Mail Transfer Protocol  
**SNA** Systems Network Architecture  
**SNAP** Subnetwork Access Protocol

<b>SNMP</b>	Simple Network Management Protocol
<b>SNPA</b>	subnetwork point of attachment
<b>SPF</b>	OSPF intra-area route
<b>SPE1</b>	OSPF external route type 1
<b>SPE2</b>	OSPF external route type 2
<b>SPIA</b>	OSPF inter-area route type
<b>SPID</b>	service profile ID
<b>SPX</b>	Sequenced Packet Exchange
<b>SQE</b>	signal quality error
<b>SRAM</b>	static random access memory
<b>SRB</b>	source routing bridge
<b>SRF</b>	specifically routed frame
<b>SRLY</b>	SDLC relay
<b>SRT</b>	source routing transparent
<b>SR-TB</b>	source routing-transparent bridge
<b>STA</b>	static
<b>STB</b>	spanning tree bridge
<b>STE</b>	spanning tree explorer
<b>STP</b>	shielded twisted pair; spanning tree protocol
<b>SVC</b>	switched virtual circuit
<b>TB</b>	transparent bridge
<b>TCN</b>	topology change notification
<b>TCP</b>	Transmission Control Protocol
<b>TCP/IP</b>	Transmission Control Protocol/Internet Protocol
<b>TEI</b>	terminal point identifier
<b>TFTP</b>	Trivial File Transfer Protocol
<b>TKR</b>	token ring
<b>TMO</b>	timeout
<b>TOS</b>	type of service
<b>TSF</b>	transparent spanning frames
<b>TTL</b>	time to live
<b>TTY</b>	teletypewriter
<b>TX</b>	transmit
<b>UA</b>	unnumbered acknowledgment
<b>UDP</b>	User Datagram Protocol
<b>UI</b>	unnumbered information



<b>UTP</b>	unshielded twisted pair
<b>VCC</b>	Virtual Channel Connection
<b>VINES</b>	Virtual NEtworking System
<b>VIR</b>	variable information rate
<b>VL</b>	virtual link
<b>VNI</b>	Virtual Network Interface
<b>VoFR</b>	Voice over Frame Relay
<b>VR</b>	virtual route
<b>WAN</b>	wide area network
<b>WRS</b>	WAN restoral/reroute
<b>X.25</b>	packet-switched networks
<b>X.251</b>	X.25 physical layer
<b>X.252</b>	X.25 frame layer
<b>X.253</b>	X.25 packet layer
<b>XID</b>	exchange identification
<b>XNS</b>	Xerox Network Systems
<b>XSUM</b>	checksum
<b>ZIP</b>	AppleTalk Zone Information Protocol
<b>ZIP2</b>	AppleTalk Zone Information Protocol 2
<b>ZIT</b>	Zone Information Table



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# Glossary

This glossary includes terms and definitions from:

- The *American National Standard Dictionary for Information Systems*, ANSI X3.172-1990, copyright 1990 by the American National Standards Institute (ANSI). Copies may be purchased from the American National Standards Institute, 11 West 42nd Street, New York, New York 10036. Definitions are identified by the symbol (A) after the definition.
- The ANSI/EIA Standard—440-A, *Fiber Optic Terminology* Copies may be purchased from the Electronic Industries Association, 2001 Pennsylvania Avenue, N.W., Washington, DC 20006. Definitions are identified by the symbol (E) after the definition.
- The *Information Technology Vocabulary* developed by Subcommittee 1, Joint Technical Committee 1, of the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC JTC1/SC1). Definitions of published parts of this vocabulary are identified by the symbol (I) after the definition; definitions taken from draft international standards, committee drafts, and working papers being developed by ISO/IEC JTC1/SC1 are identified by the symbol (T) after the definition, indicating that final agreement has not yet been reached among the participating National Bodies of SC1.
- The *IBM Dictionary of Computing*, New York: McGraw-Hill, 1994.
- Internet Request for Comments: 1208, *Glossary of Networking Terms*
- Internet Request for Comments: 1392, *Internet Users' Glossary*
- The *Object-Oriented Interface Design: IBM Common User Access Guidelines*, Carmel, Indiana: Que, 1992.

The following cross-references are used in this glossary:

### Contrast with:

This refers to a term that has an opposed or substantively different meaning.

### Synonym for:

This indicates that the term has the same meaning as a preferred term, which is defined in its proper place in the glossary.

### Synonymous with:

This is a backward reference from a defined term to all other terms that have the same meaning.

**See:** This refers the reader to multiple-word terms that have the same last word.

### See also:

This refers the reader to terms that have a related, but not synonymous, meaning.

## A

**AAL.** ATM Adaptation Layer, the layer that adapts user data to/from the ATM network by adding/removing headers and segmenting/reassembling the data into/from cells.

**AAL-5.** ATM Adaptation Layer 5, one of several standard AALs. AAL-5 was designed for data communications, and is used by LAN Emulation and Classical IP.

**abstract syntax.** A data specification that includes all distinctions that are needed in data transmissions, but that omits (abstracts) other details such as those that depend on specific computer architectures. See also *abstract syntax notation 1 (ASN.1)* and *basic encoding rules (BER)*.

**abstract syntax notation 1 (ASN.1).** The Open Systems Interconnection (OSI) method for abstract syntax specified in the following standards:

- ITU-T Recommendation X.208 (1988) | ISO/IEC 8824: 1990
- ITU-T Recommendation X.680 (1994) | ISO/IEC 8824-1: 1994

See also *basic encoding rules (BER)*.

**ACCESS.** In the Simple Network Management Protocol (SNMP), the clause in a Management Information Base (MIB) module that defines the minimum level of support that a managed node provides for an object.

**acknowledgment.** (1) The transmission, by a receiver, of acknowledgment characters as an affirmative response to a sender. (T) (2) An indication that an item sent was received.

**active.** (1) Operational. (2) Pertaining to a node or device that is connected or is available for connection to another node or device.

**active monitor.** In a token-ring network, a function performed at any one time by one ring station that

initiates the transmission of tokens and provides token error recovery facilities. Any active adapter on the ring has the ability to provide the active monitor function if the current active monitor fails.

**address.** In data communication, the unique code assigned to each device, workstation, or user connected to a network.

**address mapping table (AMT).** A table, maintained within the AppleTalk router, that provides a current mapping of node addresses to hardware addresses.

**address mask.** For internet subnetworking, a 32-bit mask used to identify the subnetwork address bits in the host portion of an IP address. Synonymous with *subnet mask* and *subnetwork mask*.

**address resolution.** (1) A method for mapping network-layer addresses to media-specific addresses. (2) See also *Address Resolution Protocol (ARP)* and *AppleTalk Address Resolution Protocol (AARP)*.

**Address Resolution Protocol (ARP).** (1) In the Internet suite of protocols, the protocol that dynamically maps an IP address to an address used by a supporting metropolitan or local area network such as Ethernet or token-ring. (2) See also *Reverse Address Resolution Protocol (RARP)*.

**addressing.** In data communication, the way in which a station selects the station to which it is to send data.

**adjacent nodes.** Two nodes connected together by at least one path that connects no other node. (T)

**Administrative Domain.** A collection of hosts and routers, and the interconnecting networks, managed by a single administrative authority.

**Advanced Peer-to-Peer Networking (APPN).** An extension to SNA featuring (a) greater distributed network control that avoids critical hierarchical dependencies, thereby isolating the effects of single points of failure; (b) dynamic exchange of network topology information to foster ease of connection, reconfiguration, and adaptive route selection; (c) dynamic definition of network resources; and (d) automated resource registration and directory lookup. APPN extends the LU 6.2 peer orientation for end-user services to network control and supports multiple LU types, including LU 2, LU 3, and LU 6.2.

**Advanced Peer-to-Peer Networking (APPN) end node.** A node that provides a broad range of end-user services and supports sessions between its local control point (CP) and the CP in an adjacent network node. It uses these sessions to dynamically register its resources with the adjacent CP (its network node server), to send and receive directory search requests, and to obtain management services. An APPN end node can also attach to a subarea network as a peripheral node or to other end nodes.

**Advanced Peer-to-Peer Networking (APPN) network.** A collection of interconnected network nodes and their client end nodes.

**Advanced Peer-to-Peer Networking (APPN) network node.** A node that offers a broad range of end-user services and that can provide the following:

- Distributed directory services, including registration of its domain resources to a central directory server
- Topology database exchanges with other APPN network nodes, enabling network nodes throughout the network to select optimal routes for LU-LU sessions based on requested classes of service
- Session services for its local LUs and client end nodes
- Intermediate routing services within an APPN network

**Advanced Peer-to-Peer Networking (APPN) node.** An APPN network node or an APPN end node.

**agent.** A system that assumes an agent role.

**alert.** A message sent to a management services focal point in a network to identify a problem or an impending problem.

**all-stations address.** In communications, synonym for *broadcast address*.

**American National Standards Institute (ANSI).** An organization consisting of producers, consumers, and general interest groups, that establishes the procedures by which accredited organizations create and maintain voluntary industry standards in the United States. (A)

**analog.** (1) Pertaining to data consisting of continuously variable physical quantities. (A) (2) Contrast with *digital*.

**AppleTalk.** A network protocol developed by Apple Computer, Inc. This protocol is used to interconnect network devices, which can be a mixture of Apple and non-Apple products.

**AppleTalk Address Resolution Protocol (AARP).** In AppleTalk networks, a protocol that (a) translates AppleTalk node addresses into hardware addresses and (b) reconciles addressing discrepancies in networks that support more than one set of protocols.

**AppleTalk Transaction Protocol (ATP).** In AppleTalk networks, a protocol that provides client/server request and response functions for hosts accessing the Zone Information Protocol (ZIP) for zone information.

**APPN network.** See *Advanced Peer-to-Peer Networking (APPN) network*.

**APPN network node.** See *Advanced Peer-to-Peer Networking (APPN) network node*.

**arbitrary MAC addressing (AMA).** In DECnet architecture, an addressing scheme used by DECnet Phase IV-Prime that supports universally administered addresses and locally administered addresses.

**area.** In Internet and DECnet routing protocols, a subset of a network or gateway grouped together by definition of the network administrator. Each area is self-contained; knowledge of an area's topology remains hidden from other areas.

**asynchronous (ASYNCR).** Pertaining to two or more processes that do not depend upon the occurrence of specific events such as common timing signals. (T)

**ATM.** Asynchronous Transfer Mode, a connection-oriented, high-speed networking technology based on cell switching.

**ATMARP.** ARP in Classical IP.

**attachment unit interface (AUI).** In a local area network, the interface between the medium attachment unit and the data terminal equipment within a data station. (I) (A)

**Attribute Value Pair (AVP).** A uniform method of encoding message types and bodies. This method maximizes the extensibility while permitting interoperability of L2TP.

**authentication failure.** In the Simple Network Management Protocol (SNMP), a trap that may be generated by an authentication entity when a requesting client is not a member of the SNMP community.

**autonomous system.** In TCP/IP, a group of networks and routers under one administrative authority. These networks and routers cooperate closely to propagate network reachability (and routing) information among themselves using an interior gateway protocol of their choice.

**autonomous system number.** In TCP/IP, a number assigned to an autonomous system by the same central authority that also assigns IP addresses. The autonomous system number makes it possible for automated routing algorithms to distinguish autonomous systems.

## B

**backbone.** (1) In a local area network multiple-bridge ring configuration, a high-speed link to which the rings are connected by means of bridges or routers. A backbone may be configured as a bus or as a ring. (2) In a wide area network, a high-speed link to which nodes or data switching exchanges (DSEs) are connected.

**backbone network.** A central network to which smaller networks, normally of lower speed, connect. The

backbone network usually has a much higher capacity than the networks it helps interconnect or is a wide-area network (WAN) such as a public packet-switched datagram network.

**backbone router.** (1) A router used to transmit data between areas. (2) One in a series of routers that is used to interconnect networks into a larger internet.

**Bandwidth.** The bandwidth of an optical link designates the information-carrying capacity of the link and is related to the maximum bit rate that a fiber link can support.

**basic transmission unit (BTU).** In SNA, the unit of data and control information passed between path control components. A BTU can consist of one or more path information units (PIUs).

**baud.** In asynchronous transmission, the unit of modulation rate corresponding to one unit interval per second; that is, if the duration of the unit interval is 20 milliseconds, the modulation rate is 50 baud. (A)

**bootstrap.** (1) A sequence of instructions whose execution causes additional instructions to be loaded and executed until the complete computer program is in storage. (T) (2) A technique or device designed to bring itself into a desired state by means of its own action, for example, a machine routine whose first few instructions are sufficient to bring the rest of itself into the computer from an input device. (A)

**Border Gateway Protocol (BGP).** An Internet Protocol (IP) routing protocol used between domains and autonomous systems.

**border router.** In Internet communications, a router, positioned at the edge of an autonomous system, that communicates with a router that is positioned at the edge of a different autonomous system.

**bridge.** A functional unit that interconnects multiple LANs (locally or remotely) that use the same logical link control protocol but that can use different medium access control protocols. A bridge forwards a frame to another bridge based on the medium access control (MAC) address.

**bridge identifier.** An 8-byte field, used in a spanning tree protocol, composed of the MAC address of the port with the lowest port identifier and a user-defined value.

**bridging.** In LANs, the forwarding of a frame from one LAN segment to another. The destination is specified by the medium access control (MAC) sublayer address encoded in the destination address field of the frame header.

**broadcast.** (1) Transmission of the same data to all destinations. (T) (2) Simultaneous transmission of data to more than one destination. (3) Contrast with *multicast*.

**broadcast address.** In communications, a station address (eight 1's) reserved as an address common to all stations on a link. Synonymous with *all-stations address*.

## C

**cache.** (1) A special-purpose buffer storage, smaller and faster than main storage, used to hold a copy of instructions and data obtained from main storage and likely to be needed next by the processor. (T) (2) A buffer storage that contains frequently accessed instructions and data; it is used to reduce access time. (3) An optional part of the directory database in network nodes where frequently used directory information may be stored to speed directory searches. (4) To place, hide, or store in a cache.

**call request packet.** (1) A call supervision packet that a data terminal equipment (DTE) transmits to ask that a connection for a call be established throughout the network. (2) In X.25 communications, a call supervision packet transmitted by a DTE to ask for a call establishment through the network.

**canonical address.** In LANs, the IEEE 802.1 format for the transmission of medium access control (MAC) addresses for token-ring and Ethernet adapters. In canonical format, the least significant (rightmost) bit of each address byte is transmitted first. Contrast with *noncanonical address*.

**carrier.** An electric or electromagnetic wave or pulse train that may be varied by a signal bearing information to be transmitted over a communication system. (T)

**carrier detect.** Synonym for *received line signal detector (RLSD)*.

**carrier sense.** In a local area network, an ongoing activity of a data station to detect whether another station is transmitting. (T)

**carrier sense multiple access with collision detection (CSMA/CD).** A protocol that requires carrier sense and in which a transmitting data station that detects another signal while transmitting, stops sending, sends a jam signal, and then waits for a variable time before trying again. (T) (A)

**CCITT.** International Telegraph and Telephone Consultative Committee. This was an organization of the International Telecommunication Union (ITU). On 1 March 1993 the ITU was reorganized, and responsibilities for standardization were placed in a subordinate organization named the Telecommunication Standardization Sector of the Telecommunication Union (ITU-TS). "CCITT" continues to be used for recommendations that were approved before the reorganization.

**channel.** (1) A path along which signals can be sent, for example, data channel, output channel. (A) (2) A functional unit, controlled by the processor, that handles the transfer of data between processor storage and local peripheral equipment.

**channel service unit (CSU).** A unit that provides the interface to a digital network. The CSU provides line conditioning (or equalization) functions, which keep the signal's performance consistent across the channel bandwidth; signal reshaping, which constitutes the binary pulse stream; and loopback testing, which includes the transmission of test signals between the CSU and the network carrier's office channel unit. See also *data service unit (DSU)*.

**channelization.** The process of breaking the bandwidth on a communication line into a number of channels, possibly of different size. Also called **time division multiplexing (TDM)**.

**checksum.** (1) The sum of a group of data associated with the group and used for checking purposes. (T) (2) In error detection, a function of all bits in a block. If the written and calculated sums do not agree, an error is indicated. (3) On a diskette, data written in a sector for error detection purposes; a calculated checksum that does not match the checksum of data written in the sector indicates a bad sector. The data are either numeric or other character strings regarded as numeric for the purpose of calculating the checksum.

**circuit switching.** (1) A process that, on demand, connects two or more data terminal equipment (DTEs) and permits the exclusive use of a data circuit between them until the connection is released. (I) (A) (2) Synonymous with *line switching*.

**class A network.** In Internet communications, a network in which the high-order (most significant) bit of the IP address is set to 0 and the host ID occupies the three low-order octets.

**class B network.** In Internet communications, a network in which the two high-order (most significant and next-to-most significant) bits of the IP address are set to 1 and 0, respectively, and the host ID occupies the two low-order octets.

**class of service (COS).** A set of characteristics (such as route security, transmission priority, and bandwidth) used to construct a route between session partners. The class of service is derived from a mode name specified by the initiator of a session.

**client.** (1) A functional unit that receives shared services from a server. (T) (2) A user.

**client/server.** In communications, the model of interaction in distributed data processing in which a program at one site sends a request to a program at



another site and awaits a response. The requesting program is called a client; the answering program is called a server.

**clocking.** (1) In binary synchronous communication, the use of clock pulses to control synchronization of data and control characters. (2) A method of controlling the number of data bits sent on a telecommunication line in a given time.

**collision.** An unwanted condition that results from concurrent transmissions on a channel. (T)

**collision detection.** In carrier sense multiple access with collision detection (CSMA/CD), a signal indicating that two or more stations are transmitting simultaneously.

**Committed information rate.** The maximum amount of data in bits that the network agrees to deliver.

**community.** In the Simple Network Management Protocol (SNMP), an administrative relationship between entities.

**community name.** In the Simple Network Management Protocol (SNMP), a string of octets identifying a community.

**compression.** (1) The process of eliminating gaps, empty fields, redundancies, and unnecessary data to shorten the length of records or blocks. (2) Any encoding to reduce the number of bits used to represent a given message or record.

**configuration.** (1) The manner in which the hardware and software of an information processing system are organized and interconnected. (T) (2) The devices and programs that make up a system, subsystem, or network.

**configuration database (CDB).** A database that stores the configuration parameters of one or several devices. It is prepared and updated using the configuration program.

**configuration file.** A file that specifies the characteristics of a system device or network.

**configuration parameter.** A variable in a configuration definition, the values of which can characterize the relationship of a product to other products in the same network or can define characteristics of the product itself.

**configuration report server (CRS).** In the IBM Token-Ring Network Bridge Program, the server that accepts commands from the LAN Network Manager (LNM) to get station information, set station parameters, and remove stations on its ring. This server also collects and forwards configuration reports generated by stations

on its ring. The configuration reports include the new active monitor reports and the nearest active upstream neighbor (NAUN) reports.

**congestion.** See *network congestion*.

**connection.** In data communication, an association established between functional units for conveying information. (I) (A)

**control point (CP).** (1) A component of an APPN or LEN node that manages the resources of that node. In an APPN node, the CP is capable of engaging in CP-CP sessions with other APPN nodes. In an APPN network node, the CP also provides services to adjacent end nodes in the APPN network. (2) A component of a node that manages resources of that node and optionally provides services to other nodes in the network. Examples are a system services control point (SSCP) in a type 5 subarea node, a network node control point (NNCP) in an APPN network node, and an end node control point (ENCP) in an APPN or LEN end node. An SSCP and an NNCP can provide services to other nodes.

**control point management services (CPMS).** A component of a control point, consisting of management services function sets, that provides facilities to assist in performing problem management, performance and accounting management, change management, and configuration management. Capabilities provided by the CPMS include sending requests to physical unit management services (PUMS) to test system resources, collecting statistical information (for example, error and performance data) from PUMS about the system resources, and analyzing and presenting test results and statistical information collected about the system resources. Analysis and presentation responsibilities for problem determination and performance monitoring can be distributed among multiple CPMSs.

**control point management services unit (CP-MSU).** The message unit that contains management services data and flows between management services function sets. This message unit is in general data stream (GDS) format. See also *management services unit (MSU)* and *network management vector transport (NMVT)*.

**CU Logical Address.** The Control Unit address defined in the host for the 2216. This value is defined in the host Input/Output Configuration Program (IOCP) by the CUADD statement on the CNTLUNIT macro instruction. The Control Unit Address must be unique for each logical partition defined on the same host.

## D

**D-bit.** Delivery-confirmation bit. In X.25 communications, the bit in a data packet or call-request packet that is set to 1 if end-to-end acknowledgment (delivery confirmation) is required from the recipient.

**daemon.** A program that runs unattended to perform a standard service. Some daemons are triggered automatically to perform their task; others operate periodically.

**data carrier detect (DCD).** Synonym for *received line signal detector (RLSD)*.

**data circuit.** (1) A pair of associated transmit and receive channels that provide a means of two-way data communication. (1) (2) In SNA, synonym for *link connection*. (3) See also *physical circuit* and *virtual circuit*.

**Notes:**

1. Between data switching exchanges, the data circuit may include data circuit-terminating equipment (DCE), depending on the type of interface used at the data switching exchange.
2. Between a data station and a data switching exchange or data concentrator, the data circuit includes the data circuit-terminating equipment at the data station end, and may include equipment similar to a DCE at the data switching exchange or data concentrator location.

**data circuit-terminating equipment (DCE).** In a data station, the equipment that provides the signal conversion and coding between the data terminal equipment (DTE) and the line. (1)

**Notes:**

1. The DCE may be separate equipment or an integral part of the DTE or of the intermediate equipment.
2. A DCE may perform other functions that are usually performed at the network end of the line.

**data link connection identifier (DLCI).** The numeric identifier of a frame-relay subport or PVC segment in a frame-relay network. Each subport in a single frame-relay port has a unique DLCI. The following table, excerpted from the American National Standards Institute (ANSI) Standard T1.618 and the International Telegraph and Telephone Consultative Committee (ITU-T/CCITT) Standard Q.922, indicates the functions associated with certain DLCI values:

DLCI Values	Function
0	in-channel signaling
1–15	reserved
16–991	assigned using frame-relay connection procedures
992–1007	Layer 2 management of frame-relay bearer service
1008–1022	reserved
1023	in-channel layer management

**data link control (DLC).** A set of rules used by nodes on a data link (such as an SDLC link or a token ring) to accomplish an orderly exchange of information.

**data link control (DLC) layer.** In SNA, the layer that consists of the link stations that schedule data transfer over a link between two nodes and perform error control for the link. Examples of data link control are SDLC for serial-by-bit link connection and data link control for the System/370 channel.

**Note:** The DLC layer is usually independent of the physical transport mechanism and ensures the integrity of data that reaches the higher layers.

**data link layer.** In the Open Systems Interconnection reference model, the layer that provides services to transfer data between entities in the network layer over a communication link. The data link layer detects and possibly corrects errors that may occur in the physical layer. (T)

**data link level.** (1) In the hierarchical structure of a data station, the conceptual level of control or processing logic between high level logic and the data link that maintains control of the data link. The data link level performs such functions as inserting transmit bits and deleting receive bits; interpreting address and control fields; generating, transmitting, and interpreting commands and responses; and computing and interpreting frame check sequences. See also *packet level* and *physical level*. (2) In X.25 communications, synonym for *frame level*.

**data link switching (DLSw).** A method of transporting network protocols that use IEEE 802.2 logical link control (LLC) type 2. SNA and NetBIOS are examples of protocols that use LLC type 2. See also *encapsulation* and *spoofing*.

**data packet.** In X.25 communications, a packet used for the transmission of user data on a virtual circuit at the DTE/DCE interface.

**data service unit (DSU).** A device that provides a digital data service interface directly to the data terminal equipment. The DSU provides loop equalization, remote and local testing capabilities, and a standard EIA/CCITT interface.

**data set ready (DSR).** Synonym for *DCE ready*.

**data switching exchange (DSE).** The equipment installed at a single location to provide switching functions, such as circuit switching, message switching, and packet switching. (1)

**data terminal equipment (DTE).** That part of a data station that serves as a data source, data sink, or both. (1) (A)

**data terminal ready (DTR).** A signal to the modem used with the EIA 232 protocol.



**data transfer rate.** The average number of bits, characters, or blocks per unit time passing between corresponding equipment in a data transmission system. (I)

**Notes:**

1. The rate is expressed in bits, characters, or blocks per second, minute, or hour.
2. Corresponding equipment should be indicated; for example, modems, intermediate equipment, or source and sink.

**datagram.** (1) In packet switching, a self-contained packet, independent of other packets, that carries information sufficient for routing from the originating data terminal equipment (DTE) to the destination DTE without relying on earlier exchanges between the DTEs and the network. (I) (2) In TCP/IP, the basic unit of information passed across the Internet environment. A datagram contains a source and destination address along with the data. An Internet Protocol (IP) datagram consists of an IP header followed by the transport layer data. (3) See also *packet* and *segment*.

**Datagram Delivery Protocol (DDP).** In AppleTalk networks, a protocol that provides network connectivity by means of connectionless socket-to-socket delivery service on the internet layer.

**DCE ready.** In the EIA 232 standard, a signal that indicates to the data terminal equipment (DTE) that the local data circuit-terminating equipment (DCE) is connected to the communication channel and is ready to send data. Synonymous with *data set ready (DSR)*.

**DECnet.** A network architecture that defines the operation of a family of software modules, databases, and hardware components typically used to tie Digital Equipment Corporation systems together for resource sharing, distributed computation, or remote system configuration. DECnet network implementations follow the Digital Network Architecture (DNA) model.

**default.** Pertaining to an attribute, condition, value, or option that is assumed when none is explicitly specified. (I)

**dependent LU requester (DLUR).** An APPN end node or an APPN network node that owns dependent LUs, but requests that a dependent LU server provide the SSCP services for those dependent LUs.

**designated router.** A router that informs end nodes of the existence and identity of other routers. The selection of the designated router is based upon the router with the highest priority. When several routers share the highest priority, the router with the highest station address is selected.

**destination node.** The node to which a request or data is sent.

**destination port.** The 8-port asynchronous adapter that serves as a connection point with a serial service.

**destination service access point (DSAP).** In SNA and TCP/IP, a logical address that allows a system to route data from a remote device to the appropriate communications support. Contrast with *source service access point (SSAP)*.

**device.** A mechanical, electrical, or electronic contrivance with a specific purpose.

**device address.** The unit address transmitted on the channel path to select a 2216 device. It is also referred to as subchannel number in S/370 I/O architecture. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device.

**digital.** (1) Pertaining to data that consist of digits. (T) (2) Pertaining to data in the form of digits. (A) (3) Contrast with *analog*.

**Digital Network Architecture (DNA).** The model for all DECnet hardware and software implementations.

**direct memory access (DMA).** The system facility that allows a device on the Micro Channel bus to get direct access to the system or bus memory without the intervention of the system processor.

**directory.** A table of identifiers and references to the corresponding items of data. (I) (A)

**directory service (DS).** An application service element that translates the symbolic names used by application processes into the complete network addresses used in an OSI environment. (T)

**directory services (DS).** A control point component of an APPN node that maintains knowledge of the location of network resources.

**disable.** To make nonfunctional.

**disabled.** (1) Pertaining to a state of a processing unit that prevents the occurrence of certain types of interruptions. (2) Pertaining to the state in which a transmission control unit or audio response unit cannot accept incoming calls on a line.

**domain.** (1) That part of a computer network in which the data processing resources are under common control. (T) (2) In Open Systems Interconnection (OSI), a part of a distributed system or a set of managed objects to which a common policy applies. (3) See *Administrative Domain* and *domain name*.

**domain name.** In the Internet suite of protocols, a name of a host system. A domain name consists of a sequence of subnames separated by a delimiter character. For example, if the fully qualified domain

name (FQDN) of a host system is `ralvm7.vnet.ibm.com`, each of the following is a domain name:

- `ralvm7.vnet.ibm.com`
- `vnet.ibm.com`
- `ibm.com`

**domain name server.** In the Internet suite of protocols, a server program that supplies name-to-address translation by mapping domain names to IP addresses. Synonymous with *name server*.

**Domain Name System (DNS).** In the Internet suite of protocols, the distributed database system used to map domain names to IP addresses.

**dotted decimal notation.** The syntactical representation for a 32-bit integer that consists of four 8-bit numbers written in base 10 with periods (dots) separating them. It is used to represent IP addresses.

**dump.** (1) Data that has been dumped. (T) (2) To copy the contents of all or part of virtual storage for the purpose of collecting error information.

**dynamic reconfiguration (DR).** The process of changing the network configuration (peripheral PUs and LUs) without regenerating complete configuration tables or deactivating the affected major node.

**Dynamic Routing.** Routing using learned routes rather than routes statically configured at initialization.

## E

**echo.** In data communication, a reflected signal on a communications channel. For example, on a communications terminal, each signal is displayed twice, once when entered at the local terminal and again when returned over the communications link. This allows the signals to be checked for accuracy.

**EIA 232.** In data communication, a specification of the Electronic Industries Association (EIA) that defines the interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE), using serial binary data interchange.

**Electronic Industries Association (EIA).** An organization of electronics manufacturers that advances the technological growth of the industry, represents the views of its members, and develops industry standards.

**EIA unit.** A unit of measure, established by the Electronic Industries Association, equal to 44.45 millimeters (1.75 inches).

**encapsulation.** (1) In communications, a technique used by layered protocols by which a layer adds control information to the protocol data unit (PDU) from the layer it supports. In this respect, the layer encapsulates the data from the supported layer. In the Internet suite of protocols, for example, a packet would contain

control information from the physical layer, followed by control information from the network layer, followed by the application protocol data. (2) See also *data link switching*.

**encode.** To convert data by the use of a code in such a manner that reconversion to the original form is possible. (T)

**end node (EN).** (1) See *Advanced Peer-to-Peer Networking (APPN) end node* and *low-entry networking (LEN) end node*. (2) In communications, a node that is frequently attached to a single data link and cannot perform intermediate routing functions.

**entry point (EP).** In SNA, a type 2.0, type 2.1, type 4, or type 5 node that provides distributed network management support. It sends network management data about itself and the resources it controls to a focal point for centralized processing, and it receives and executes focal-point initiated commands to manage and control its resources.

**Ethernet.** A 10-Mbps baseband local area network that allows multiple stations to access the transmission medium at will without prior coordination, avoids contention by using carrier sense and deference, and resolves contention by using collision detection and delayed retransmission. Ethernet uses carrier sense multiple access with collision detection (CSMA/CD).

**exception.** An abnormal condition such as an I/O error encountered in processing a data set or a file.

**exception response (ER).** In SNA, a protocol requested in the form-of-response-requested field of a request header that directs the receiver to return a response only if the request is unacceptable as received or cannot be processed; that is, a negative response, but not a positive response, can be returned. Contrast with *definite response* and *no response*.

**exchange identification (XID).** A specific type of basic link unit that is used to convey node and link characteristics between adjacent nodes. XIDs are exchanged between link stations before and during link activation to establish and negotiate link and node characteristics, and after link activation to communicate changes in these characteristics.

**explicit route (ER).** In SNA, a series of one or more transmission groups that connect two subarea nodes. An explicit route is identified by an origin subarea address, a destination subarea address, an explicit route number, and a reverse explicit route number. Contrast with *virtual route (VR)*.

**explorer frame.** See *explorer packet*.

**explorer packet.** In LANs, a packet that is generated by the source host and that traverses the entire source routing part of a LAN, gathering information on the possible paths available to the host.

**exterior gateway.** In Internet communications, a gateway on one autonomous system that communicates with another autonomous system. Contrast with *interior gateway*.

**Exterior Gateway Protocol (EGP).** In the Internet suite of protocols, a protocol, used between domains and autonomous systems, that enables network reachability information to be advertised and exchanged. IP network addresses in one autonomous system are advertised to another autonomous system by means of EGP-participating routers. An example of an EGP is the Border Gateway Protocol (BGP). Contrast with Interior Gateway Protocol (IGP).

## F

**fax.** Hardcopy received from a facsimile machine. Synonymous with *telecopy*.

**File Transfer Protocol (FTP).** In the Internet suite of protocols, an application layer protocol that uses TCP and Telnet services to transfer bulk-data files between machines or hosts.

**flash memory.** A data storage device that is programmable, erasable, and does not require continuous power. The chief advantage of flash memory over other programmable and erasable data storage devices is that it can be reprogrammed without being removed from the circuit board.

**flow control.** (1) In SNA, the process of managing the rate at which data traffic passes between components of the network. The purpose of flow control is to optimize the rate of flow of message units with minimum congestion in the network; that is, to neither overflow the buffers at the receiver or at intermediate routing nodes, nor leave the receiver waiting for more message units. (2) See also *padding*.

**fragment.** See *fragmentation*.

**fragmentation.** (1) The process of dividing a datagram into smaller parts, or fragments, to match the capabilities of the physical medium over which it is to be transmitted. (2) See also *segmenting*.

**frame.** (1) In Open Systems Interconnection architecture, a data structure pertaining to a particular area of knowledge and consisting of slots that can accept the values of specific attributes and from which inferences can be drawn by appropriate procedural attachments. (T) (2) The unit of transmission in some local area networks, including the IBM Token-Ring Network. It includes delimiters, control characters, information, and checking characters. (3) In SDLC, the vehicle for every command, every response, and all information that is transmitted using SDLC procedures.

**frame level.** Synonymous with *data link level*. See *link level*.

**frame relay.** (1) An interface standard describing the boundary between a user's equipment and a fast-packet network. In frame-relay systems, flawed frames are discarded; recovery comes end-to-end rather than hop-by-hop. (2) A technique derived from the integrated services digital network (ISDN) D channel standard. It assumes that connections are reliable and dispenses with the overhead of error detection and control within the network.

**front-end processor.** A processor such as the IBM 3745 or 3174, that relieves a main frame from the communication control tasks.

## G

**gateway.** (1) A functional unit that interconnects two computer networks with different network architectures. A gateway connects networks or systems of different architectures. A bridge interconnects networks or systems with the same or similar architectures. (T) (2) In the IBM Token-Ring Network, a device and its associated software that connect a local area network to another local area network or a host that uses different logical link protocols. (3) In TCP/IP, synonym for *router*.

**general data stream (GDS).** The data stream used for conversations in LU 6.2 sessions.

**general data stream (GDS) variable.** A type of RU substructure that is preceded by an identifier and a length field and includes either application data, user control data, or SNA-defined control data.

## H

**header.** (1) System-defined control information that precedes user data. (2) The portion of a message that contains control information for the message such as one or more destination fields, name of the originating station, input sequence number, character string indicating the type of message, and priority level for the message.

**heap memory.** The amount of RAM used to dynamically allocate data structures.

**Hello.** A protocol used by a group of cooperating, trusting routers to allow them to discover minimal delay routes.

**hello message.** (1) A message sent periodically to establish and test reachability between routers or between routers and hosts. (2) In the Internet suite of protocols, a message defined by the Hello protocol as an Interior Gateway Protocol (IGP).

**heuristic.** Pertaining to exploratory methods of problem solving in which solutions are discovered by evaluation of the progress made toward the final result.

**high-level data link control (HDLC).** In data communication, the use of a specified series of bits to control data links in accordance with the International Standards for HDLC: ISO 3309 Frame Structure and ISO 4335 Elements of Procedures.

**high-performance routing (HPR).** An addition to the Advanced Peer-to-Peer Networking (APPN) architecture that enhances data routing performance and reliability, especially when using high-speed links.

**hop.** (1) In APPN, a portion of a route that has no intermediate nodes. It consists of only a single transmission group connecting adjacent nodes. (2) To the routing layer, the logical distance between two nodes in a network.

**hop count.** (1) A metric or measure of distance between two points. (2) In Internet communications, the number of routers that a datagram passes through on its way to its destination. (3) In SNA, a measure of the number of links to be traversed in a path to a destination.

**host.** In the Internet suite of protocols, an end system. The end system can be any workstation; it does not have to be a mainframe.

**hot pluggable.** Refers to a hardware component that can be installed or removed without disturbing the operation of any other resource that is not connected to, or dependant on, this component.

**hub (intelligent).** A wiring concentrator, such as the IBM 8260, that provides bridging and routing functions for LANs with different cables and protocols.

**hysteresis.** The amount the temperature must change past the set alert threshold before the alert condition is cleared.

I

**I-frame.** Information frame.

**information (I) frame.** A frame in I format used for numbered information transfer.

**input/output channel.** In a data processing system, a functional unit that handles transfer of data between internal and peripheral equipment. (I) (A)

**Integrated Digital Network Exchange (IDNX).** A processor integrating voice, data, and image applications. It also manages the transmission resources, and connects to multiplexers and network management support systems. It allows integration of equipment from different vendors.

**integrated services digital network (ISDN).** A digital end-to-end telecommunication network that supports multiple services including, but not limited to, voice and data.

**Note:** ISDNs are used in public and private network architectures.

**interface.** (1) A shared boundary between two functional units, defined by functional characteristics, signal characteristics, or other characteristics, as appropriate. The concept includes the specification of the connection of two devices having different functions. (T) (2) Hardware, software, or both, that links systems, programs, or devices.

**interior gateway.** In Internet communications, a gateway that communicates only with its own autonomous system. Contrast with *exterior gateway*.

**Interior Gateway Protocol (IGP).** In the Internet suite of protocols, a protocol used to propagate network reachability and routing information within an autonomous system. Examples of IGPs are Routing Information Protocol (RIP) and Open Shortest Path First (OSPF).

**interleaving.** (1) The alternating of two or more operations or functions through the overlapped use of a computer facility. (2) In data transmission, the alternating of packets from one data stream with packets from another.

**intermediate node.** A node that is at the end of more than one branch. (T)

**intermediate session routing (ISR).** A type of routing function within an APPN network node that provides session-level flow control and outage reporting for all sessions that pass through the node but whose end points are elsewhere.

**International Organization for Standardization (ISO).** An organization of national standards bodies from various countries established to promote development of standards to facilitate international exchange of goods and services, and develop cooperation in intellectual, scientific, technological, and economic activity.

**International Telecommunication Union (ITU).** The specialized telecommunication agency of the United Nations, established to provide standardized communication procedures and practices, including frequency allocation and radio regulations worldwide.

**internet.** A collection of networks interconnected by a set of routers that allow them to function as a single, large network. See also *Internet*.

**Internet.** The internet administered by the Internet Architecture Board (IAB), consisting of large national backbone networks and many regional and campus networks all over the world. The Internet uses the Internet suite of protocols.

**Internet address.** See *IP address*.



**Internet Architecture Board (IAB).** The technical body that oversees the development of the Internet suite of protocols that are known as TCP/IP.

**Internet Control Message Protocol (ICMP).** The protocol used to handle errors and control messages in the Internet Protocol (IP) layer. Reports of problems and incorrect datagram destinations are returned to the original datagram source. ICMP is part of the Internet Protocol.

**Internet Control Protocol (ICP).** The Virtual NETworking System (VINES) protocol that provides exception notifications, metric notifications, and PING support. See also *RouTing update Protocol (RTP)*.

**Internet Engineering Task Force (IETF).** The task force of the Internet Architecture Board (IAB) that is responsible for solving the short-term engineering needs of the Internet.

**Internetwork Packet Exchange (IPX).** (1) The network protocol used to connect Novell's servers, or any workstation or router that implements IPX, with other workstations. Although similar to the Internet Protocol (IP), IPX uses different packet formats and terminology. (2) See also *Xerox Network Systems (XNS)*.

**Internet Protocol (IP).** A connectionless protocol that routes data through a network or interconnected networks. IP acts as an intermediary between the higher protocol layers and the physical network. However, this protocol does not provide error recovery and flow control and does not guarantee the reliability of the physical network.

**interoperability.** The capability to communicate, execute programs, or transfer data among various functional units in a way that requires the user to have little or no knowledge of the unique characteristics of those units. (T)

**intra-area routing.** In Internet communications, the routing of data within an area.

**Inverse Address Resolution Protocol (InARP).** In the Internet suite of protocols, the protocol used for locating a protocol address through the known hardware address. In a frame-relay context, the data link connection identifier (DLCI) is synonymous with the known hardware address.

**IPPN.** The interface that other protocols can use to transport data over IP.

**IP address.** The 32-bit address defined by the Internet Protocol, standard 5, Request for Comments (RFC) 791. It is usually represented in dotted decimal notation.

**IP datagram.** In the Internet suite of protocols, the fundamental unit of information transmitted through an internet. It contains source and destination addresses,

user data, and control information such as the length of the datagram, the header checksum, and flags indicating whether the datagram can be or has been fragmented.

**IP router.** A device in an IP internet that is responsible for making decisions about the paths over which network traffic will flow. Routing protocols are used to gain information about the network and to determine the best route over which the datagram should be forwarded toward the final destination. The datagrams are routed based on IP destination addresses.

**IPXWAN.** A Novell protocol that is used to exchange router-to-router information before exchanging standard Internetwork Packet Exchange (IPX) routing information and traffic over wide area networks (WANs).

## J

**jitter.** (1) Short-term non-cumulative variations of the significant instants of a digital signal from their ideal positions in time. (2) Undesirable variations of a transmitted digital signal. (3) Variations in the network delay.

## L

**L2TP Access Concentrator (LAC).** A device attached to one or more public service telephone network (PSTN) or ISDN lines capable of handling both PPP operation and of the L2TP protocol. The LAC implements the media over which L2TP operates. L2TP passes the traffic to one or more L2TP Network Servers (LNS). L2TP can tunnel any protocol carried by the PPP network.

**L2TP Network Server (LNS).** An LNS operates on any platform capable that can be a PPP end station. The LNS handles the server side of the L2TP protocol. Since L2TP relies only on the single media over which L2TP tunnels arrive, the LNS has only a single LAN or WAN interface, yet is still able to terminate calls arriving from any the full range of PPP interfaces supported by a LAC. These include asynchronous ISDN, synchronous ISDN, V.120, and other types of connections.

**LAN bridge server (LBS).** In the IBM Token-Ring Network Bridge Program, the server that keeps statistical information about frames forwarded between two or more rings (through a bridge). The LBS sends these statistics to the appropriate LAN managers through the LAN reporting mechanism (LRM).

**LAN Emulation (LE).** An ATM Forum standard that supports legacy LAN applications over ATM networks.

**LAN Emulation Client (LEC).** A LAN Emulation component that represents users of the Emulated LAN.

**LAN Emulation Configuration Server (LECS).** A LAN Emulation Service component that centralizes and disseminates configuration data.

**LAN Emulation Server (LES).** A LAN Emulation Service component that resolves LAN Destinations to ATM Addresses.

**LAN Network Manager (LNM).** An IBM licensed program that enables a user to manage and monitor LAN resources from a central workstation.

**LAN segment.** (1) Any portion of a LAN (for example, a bus or ring) that can operate independently, but that is connected to other parts of the network by means of bridges. (2) A ring or bus network without bridges.

**layer.** (1) In network architecture, a group of services that is complete from a conceptual point of view, that is one out of a set of hierarchically arranged groups, and that extends across all systems that conform to the network architecture. (T) (2) In the Open Systems Interconnection reference model, one of seven conceptually complete, hierarchically arranged groups of services, functions, and protocols, that extend across all open systems. (T) (3) In SNA, a grouping of related functions that are logically separate from the functions in other groups. Implementation of the functions in one layer can be changed without affecting functions in other layers.

**LE.** LAN Emulation. An ATM Forum standard that supports legacy LAN applications over ATM networks.

**LEC.** LAN Emulation Client. A LAN Emulation component that represents users of the Emulated LAN.

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**LES.** LAN Emulation Server. A LAN Emulation Service component that resolves LAN Destinations to ATM Addresses.

**line switching.** Synonym for *circuit switching*.

**link.** The combination of the link connection (the transmission medium) and two link stations, one at each end of the link connection. A link connection can be shared among multiple links in a multipoint or token-ring configuration.

**link access protocol balanced (LAPB).** A protocol used for accessing an X.25 network at the link level. LAPB is a duplex, asynchronous, symmetric protocol, used in point-to-point communication.

**Link Address.** For the 2216 with an ESCON Channel Adapter, a port number determined as follows: If one ESCD is in the communication path, it is the ESCON Director (ESCD) port number that is attached to the host. If two ESCDs are in the path, it is the host-side

port number of the ESCD defined with the dynamic connection. When no ESCD is in the communication path, this value must be set to X'01'.

**link-attached.** (1) Pertaining to devices that are connected to a controlling unit by a data link. (2) Contrast with *channel-attached*. (3) Synonymous with *remote*.

**link connection.** (1) The physical equipment providing two-way communication between one link station and one or more other link stations; for example, a telecommunication line and data circuit-terminating equipment (DCE). (2) In SNA, synonymous with *data circuit*.

**link level.** (1) A part of Recommendation X.25 that defines the link protocol used to get data into and out of the network across the full-duplex link connecting the subscriber's machine to the network node. LAP and LAPB are the link access protocols recommended by the CCITT. (2) See *data link level*.

**link-state.** In routing protocols, the advertised information about the usable interfaces and reachable neighbors of a router or network. The protocol's topological database is formed from the collected link-state advertisements.

**link station.** (1) The hardware and software components within a node representing a connection to an adjacent node over a specific link. For example, if node A is the primary end of a multipoint line that connects to three adjacent nodes, node A will have three link stations representing the connections to the adjacent nodes. (2) See also *adjacent link station (ALS)*.

**local.** (1) Pertaining to a device accessed directly without use of a telecommunication line. (2) Contrast with *remote*. (3) Synonym for *channel-attached*.

**local area network (LAN).** (1) A computer network located on a user's premises within a limited geographical area. Communication within a local area network is not subject to external regulations; however, communication across the LAN boundary may be subject to some form of regulation. (T) (2) A network in which a set of devices are connected to one another for communication and that can be connected to a larger network. (3) See also *Ethernet* and *token ring*. (4) Contrast with *metropolitan area network (MAN)* and *wide area network (WAN)*.

**local bridging.** A function of a bridge program that allows a single bridge to connect multiple LAN segments without using a telecommunication link. Contrast with *remote bridging*.

**local management interface (LMI).** See *local management interface (LMI) protocol*.

**local management interface (LMI) protocol.** In NCP, a set of frame-relay network management procedures

and messages used by adjacent frame-relay nodes to exchange line status information over DLCI X'00'. NCP supports both the American National Standards Institute (ANSI) and International Telegraph and Telephone Consultative Committee (ITU-T/CCITT) versions of LMI protocol. These standards refer to LMI protocol as *link integrity verification tests (LIVT)*.

**locally administered address.** In a local area network, an adapter address that the user can assign to override the universally administered address. Contrast with *universally administered address*.

**logical channel.** In packet mode operation, a sending channel and a receiving channel that together are used to send and receive data over a data link at the same time. Several logical channels can be established on the same data link by interleaving the transmission of packets.

**logical link.** A pair of link stations, one in each of two adjacent nodes, and their underlying link connection, providing a single link-layer connection between the two nodes. Multiple logical links can be distinguished while they share the use of the same physical media connecting two nodes. Examples are 802.2 logical links used on local area network (LAN) facilities and LAP E logical links on the same point-to-point physical link between two nodes. The term logical link also includes the multiple X.25 logical channels that share the use of the access link from a DTE to an X.25 network.

**logical link control (LLC).** The data link control (DLC) LAN sublayer that provides two types of DLC operation for the orderly exchange of information. The first type is connectionless service, which allows information to be sent and received without establishing a link. The LLC sublayer does not perform error recovery or flow control for connectionless service. The second type is connection-oriented service, which requires establishing a link prior to the exchange of information. Connection-oriented service provides sequenced information transfer, flow control, and error recovery.

**logical link control (LLC) protocol.** In a local area network, the protocol that governs the exchange of transmission frames between data stations independently of how the transmission medium is shared. (T) The LLC protocol was developed by the IEEE 802 committee and is common to all LAN standards.

**logical link control (LLC) protocol data unit.** A unit of information exchanged between link stations in different nodes. The LLC protocol data unit contains a destination service access point (DSAP), a source service access point (SSAP), a control field, and user data.

**logical partition.** A number assigned to a partition in a host that can operate in logically partitioned (LPAR)

mode. In LPAR mode, the ESCON adapter can share a physical fiber connection with multiple host partitions.

**Logically Partitioned (LPAR) mode.** A function of some host processors in which processing is divided into logical partitions (LPs) to provide the appearance of multiple processors. In LPAR mode, the ESCON adapter can share a physical fiber connection with multiple host partitions.

**LP.** logical partition

**LP number.** Logical partition number. This allows multiple logical host partitions, LPs, to share one ESCON fiber. This value is defined in the host Input/Output Configuration Program (IOCP) by the RESOURCE macro instruction. If the host is not using EMIF, use the default of 0 for the LP number.

**LPAR.** logically partitioned

**LPAR mode.** Logically Partitioned (LPAR) mode.

**logical unit (LU).** A type of network accessible unit that enables users to gain access to network resources and communicate with each other.

**loopback test.** A test in which signals from a tester are looped at a modem or other network element back to the tester for measurements that determine or verify the quality of the communications path.

**low-entry networking (LEN).** A capability of nodes to attach directly to one another using basic peer-to-peer protocols to support multiple and parallel sessions between logical units.

**low-entry networking (LEN) end node.** A LEN node receiving network services from an adjacent APPN network node.

**low-entry networking (LEN) node.** A node that provides a range of end-user services, attaches directly to other nodes using peer protocols, and derives network services implicitly from an adjacent APPN network node, that is, without the direct use of CP-CP sessions.

## M

**Management Information Base (MIB).** (1) A collection of objects that can be accessed by means of a network management protocol. (2) A definition for management information that specifies the information available from a host or gateway and the operations allowed. (3) In OSI, the conceptual repository of management information within an open system.

**management station.** In Internet communications, the system responsible for managing all, or a portion of, a network. The management station communicates with network management agents that reside in the

managed node by means of a network management protocol, such as the Simple Network Management Protocol (SNMP).

**mapping.** The process of converting data that is transmitted in one format by the sender into the data format that can be accepted by the receiver.

**mask.** (1) A pattern of characters used to control retention or elimination of portions of another pattern of characters. (I) (A) (2) To use a pattern of characters to control retention or elimination of portions of another pattern of characters. (I) (A)

**maximum transmission unit (MTU).** In LANs, the largest possible unit of data that can be sent on a given physical medium in a single frame. For example, the MTU for Ethernet is 1500 bytes.

**medium access control (MAC).** In LANs, the sublayer of the data link control layer that supports medium-dependent functions and uses the services of the physical layer to provide services to the logical link control (LLC) sublayer. The MAC sublayer includes the method of determining when a device has access to the transmission medium.

**medium access control (MAC) protocol.** In a local area network, the protocol that governs access to the transmission medium, taking into account the topological aspects of the network, in order to enable the exchange of data between data stations. (T)

**medium access control (MAC) sublayer.** In a local area network, the part of the data link layer that applies a medium access method. The MAC sublayer supports topology-dependent functions and uses the services of the physical layer to provide services to the logical link control sublayer. (T)

**metric.** In Internet communications, a value, associated with a route, which is used to discriminate between multiple exit or entry points to the same autonomous system. The route with the lowest metric is preferred.

**metropolitan area network (MAN).** A network formed by the interconnection of two or more networks which may operate at higher speed than those networks, may cross administrative boundaries, and may use multiple access methods. (T) Contrast with *local area network (LAN)* and *wide area network (WAN)*.

**MIB.** (1) MIB module. (2) Management Information Base.

**MIB object.** Synonym for *MIB variable*.

**MIB variable.** In the Simple Network Management Protocol (SNMP), a specific instance of data defined in a MIB module. Synonymous with *MIB object*.

**MIB view.** In the Simple Network Management Protocol (SNMP), the collection of managed objects, known to the agent, that is visible to a particular community.

**MILNET.** The military network that was originally part of ARPANET. It was partitioned from ARPANET in 1984. MILNET provides a reliable network service for military installations.

**modem (modulator/demodulator).** (1) A functional unit that modulates and demodulates signals. One of the functions of a modem is to enable digital data to be transmitted over analog transmission facilities. (T) (A) (2) A device that converts digital data from a computer to an analog signal that can be transmitted on a telecommunication line, and converts the analog signal received to data for the computer.

**module.** In the Nways Switch, a packaged functional hardware unit containing logic cards, connectors, and lights. The modules are used to package adapters, line interface couplers, voice server extensions, and other components. All modules are *hot pluggable* in the logic subracks.

**modulo.** (1) Pertaining to a modulus; for example, 9 is equivalent to 4 modulo 5. (2) See also *modulus*.

**modulus.** A number, such as a positive integer, in a relationship that divides the difference between two related numbers without leaving a remainder; for example, 9 and 4 have a modulus of 5 ( $9 - 4 = 5$ ;  $4 - 9 = -5$ ; and 5 divides both 5 and -5 without leaving a remainder).

**monitor.** (1) A device that observes and records selected activities within a data processing system for analysis. Possible uses are to indicate significant departure from the norm, or to determine levels of utilization of particular functional units. (T) (2) Software or hardware that observes, supervises, controls, or verifies operations of a system. (A) (3) The function required to initiate the transmission of a token on the ring and to provide soft-error recovery in case of lost tokens, circulating frames, or other difficulties. The capability is present in all ring stations.

**multicast.** (1) Transmission of the same data to a selected group of destinations. (T) (2) A special form of broadcast in which copies of a packet are delivered to only a subset of all possible destinations.

**multipath channel (MPC).** A channel protocol that uses multiple unidirectional subchannels for VTAM-to-VTAM bidirectional communication.

**multiple-domain support (MDS).** A technique for transporting management services data between management services function sets over LU-LU and CP-CP sessions. See also *multiple-domain support message unit (MDS-MU)*.



**multiple-domain support message unit (MDS-MU).** The message unit that contains management services data and flows between management services function sets over the LU-LU and CP-CP sessions used by multiple-domain support. This message unit, as well as the actual management services data that it contains, is in general data stream (GDS) format. See also *control point management services unit (CP-MSU)*, *management services unit (MSU)*, and *network management vector transport (NMVT)*.

## N

**Name Binding Protocol (NBP).** In AppleTalk networks, a protocol that provides name translation function from the AppleTalk entity (resource) name (character string) into an AppleTalk IP address (16-bit number) on the transport layer.

**name resolution.** In Internet communications, the process of mapping a machine name to the corresponding Internet Protocol (IP) address. See also *Domain Name System (DNS)*.

**name server.** In the Internet suite of protocols, synonym for *domain name server*.

**nearest active upstream neighbor (NAUN).** In the IBM Token-Ring Network, the station sending data directly to a given station on the ring.

**neighbor.** A router on a common subnetwork that has been designated by a network administrator to receive routing information.

**NetBIOS.** Network Basic Input/Output System. A standard interface to networks, IBM personal computers (PCs), and compatible PCs, that is used on LANs to provide message, print-server, and file-server functions. Application programs that use NetBIOS do not need to handle the details of LAN data link control (DLC) protocols.

**network.** (1) A configuration of data processing devices and software connected for information interchange. (2) A group of nodes and the links interconnecting them.

**Network Access Server (NAS).** A device providing temporary, on-demand network access to users. This access is point-to-point using PSTN or ISDN lines.

**network accessible unit (NAU).** A logical unit (LU), physical unit (PU), control point (CP), or system services control point (SSCP). It is the origin or the destination of information transmitted by the path control network. Synonymous with *network addressable unit*.

**network address.** According to ISO 7498-3, a name, unambiguous within the OSI environment, that identifies a set of network service access points.

**network addressable unit (NAU).** Synonym for *network accessible unit*.

**network architecture.** The logical structure and operating principles of a computer network. (T)

**Note:** The operating principles of a network include those of services, functions, and protocols.

**network congestion.** An undesirable overload condition caused by traffic in excess of what a network can handle.

**network identifier.** (1) In TCP/IP, that part of the IP address that defines a network. The length of the network ID depends on the type of network class (A, B, or C). (2) A 1- to 8-byte customer-selected name or an 8-byte IBM -registered name that uniquely identifies a specific subnetwork.

**Network Information Center (NIC).** In Internet communications, local, regional, and national groups throughout the world who provide assistance, documentation, training, and other services to users.

**network layer.** In Open Systems Interconnection (OSI) architecture, the layer that is responsible for routing, switching, and link-layer access across the OSI environment.

**network management.** The process of planning, organizing, and controlling a communication-oriented data processing or information system.

**network management station.** In the Simple Network Management Protocol (SNMP), a station that executes management application programs that monitor and control network elements.

**network management vector transport (NMVT).** A management services request/response unit (RU) that flows over an active session between physical unit management services and control point management services (SSCP-PU session).

**network manager.** A program or group of programs that is used to monitor, manage, and diagnose the problems of a network.

**network node (NN).** See *Advanced Peer-to-Peer Networking (APPN) network node*.

**network support station.** The processor used to locally operate and service the Nways Switch. It is used by the Nways Switch administrator or service personnel.

**network user address (NUA).** In X.25 communications, the X.121 address containing up to 15 binary code digits.

**node.** (1) In a network, a point at which one or more functional units connect channels or data circuits. (I)  
(2) Any device, attached to a network, that transmits and receives data.

**noncanonical address.** In LANs, a format for the transmission of medium access control (MAC) addresses for token-ring adapters. In noncanonical format, the most significant (leftmost) bit of each address byte is transmitted first. Contrast with *canonical address*.

**Non-Return-to-Zero Changes-on-Ones Recording (NRZ-1).** A recording method in which the ones are represented by a change in the condition of magnetization, and zeros are represented by the absence of change. Only the one signals are explicitly recorded. (Previously called *non-return-to-zero inverted*, NRZI, recording.)

**nonseed router.** In AppleTalk networks, a router that acquires network number range and zone list information from a seed router attached to the same network.

**Nways Switch.** Synonymous with IBM 2220 Nways BroadBand Switch.

**Nways Switch configuration station.** A dedicated OS/2 station running a stand-alone version of the Nways Switch Configuration Tool (NCT). It is used to generate a network configuration database and should be installed as a remote console.

## O

**Open Shortest Path First (OSPF).** In the Internet suite of protocols, a function that provides intradomain information transfer. An alternative to the Routing Information Protocol (RIP), OSPF allows the lowest-cost routing and handles routing in large regional or corporate networks.

**Open Systems Interconnection (OSI).** (1) The interconnection of open systems in accordance with standards of the International Organization for Standardization (ISO) for the exchange of information. (T) (A) (2) The use of standardized procedures to enable the interconnection of data processing systems.

**Note:** OSI architecture establishes a framework for coordinating the development of current and future standards for the interconnection of computer systems. Network functions are divided into seven layers. Each layer represents a group of related data processing and communication functions that can be carried out in a standard way to support different applications.

**Open Systems Interconnection (OSI) architecture.** Network architecture that adheres to that particular set of ISO standards that relates to Open Systems Interconnection. (T)

**Open Systems Interconnection (OSI) reference model.** A model that describes the general principles of the Open Systems Interconnection, as well as the purpose and the hierarchical arrangement of its seven layers. (T)

**origin.** An external logical unit (LU) or application program from which a message or other data originates. See also *destination*.

**orphan circuit.** A non-configured circuit whose availability is learned dynamically.

## P

**pacing.** (1) A technique by which a receiving component controls the rate of transmission of a sending component to prevent overrun or congestion. (2) See also *flow control*, *receive pacing*, *send pacing*, *session-level pacing*, and *virtual route (VR) pacing*.

**packet.** In data communication, a sequence of binary digits, including data and control signals, that is transmitted and switched as a composite whole. The data, control signals, and, possibly, error control information are arranged in a specific format. (I)

**packet internet groper (PING).** (1) In Internet communications, a program used in TCP/IP networks to test the ability to reach destinations by sending the destinations an Internet Control Message Protocol (ICMP) echo request and waiting for a reply. (2) In communications, a test of reachability.

**packet loss ratio.** The probability that a packet will not reach its destination or not reach it within a specified time.

**packet mode operation.** Synonym for *packet switching*.

**packet switching.** (1) The process of routing and transferring data by means of addressed packets so that a channel is occupied only during transmission of a packet. On completion of the transmission, the channel is made available for transfer of other packets. (I) (2) Synonymous with *packet mode operation*. See also *circuit switching*.

**parallel bridges.** A pair of bridges connected to the same LAN segment, creating redundant paths to the segment.

**parallel transmission groups.** Multiple transmission groups between adjacent nodes, with each group having a distinct transmission group number.

**path.** (1) In a network, any route between any two nodes. A path may include more than one branch. (T) (2) The series of transport network components (path control and data link control) that are traversed by the information exchanged between two network accessible units. See also *explicit route (ER)*, *route extension*, and *virtual route (VR)*.

**path control (PC).** The function that routes message units between network accessible units in the network and provides the paths between them. It converts the basic information units (BIUs) from transmission control (possibly segmenting them) into path information units (PIUs) and exchanges basic transmission units containing one or more PIUs with data link control. Path control differs by node type: some nodes (APPN nodes, for example) use locally generated session identifiers for routing, and others (subarea nodes) use network addresses for routing.

**path cost.** In link-state routing protocols, the sum of the link costs along the path between two nodes or networks.

**path information unit (PIU).** A message unit consisting of a transmission header (TH) alone, or a TH followed by a basic information unit (BIU) or a BIU segment.

**pattern-matching character.** A special character such as an asterisk (\*) or a question mark (?) that can be used to represent one or more characters. Any character or set of characters can replace a pattern-matching character. Synonymous with *global character* and *wildcard character*.

**permanent virtual circuit (PVC).** In X.25 and frame-relay communications, a virtual circuit that has a logical channel permanently assigned to it at each data terminal equipment (DTE). Call-establishment protocols are not required. Contrast with *switched virtual circuit (SVC)*.

**physical circuit.** A circuit established without multiplexing. See also *data circuit*. Contrast with *virtual circuit*.

**physical layer.** In the Open Systems Interconnection reference model, the layer that provides the mechanical, electrical, functional, and procedural means to establish, maintain, and release physical connections over the transmission medium. (T)

**physical unit (PU).** (1) The component that manages and monitors the resources (such as attached links and adjacent link stations) associated with a node, as requested by an SSCP via an SSCP-PU session. An SSCP activates a session with the physical unit in order to indirectly manage, through the PU, resources of the node such as attached links. This term applies to type 2.0, type 4, and type 5 nodes only. (2) See also *peripheral PU* and *subarea PU*.

**ping command.** The command that sends an Internet Control Message Protocol (ICMP) echo-request packet to a gateway, router, or host with the expectation of receiving a reply.

**Point-to-Point Protocol (PPP).** A protocol that provides a method for encapsulating and transmitting packets over serial point-to-point links.

**polling.** (1) On a multipoint connection or a point-to-point connection, the process whereby data stations are invited, one at a time, to transmit. (I) (2) Interrogation of devices for such purposes as to avoid contention, to determine operational status, or to determine readiness to send or receive data. (A)

**port.** (1) An access point for data entry or exit. (2) A connector on a device to which cables for other devices such as display stations and printers are attached. (3) The representation of a physical connection to the link hardware. A port is sometimes referred to as an adapter; however, there can be more than one port on an adapter. There may be one or more ports controlled by a single DLC process. (4) In the Internet suite of protocols, a 16-bit number used to communicate between TCP or the User Datagram Protocol (UDP) and a higher-level protocol or application. Some protocols, such as File Transfer Protocol (FTP) and Simple Mail Transfer Protocol (SMTP), use the same well-known port number in all TCP/IP implementations. (5) An abstraction used by transport protocols to distinguish among multiple destinations within a host machine. (6) Synonymous with *socket*.

**port number.** In Internet communications, the identification of an application entity to the transport service.

**private branch exchange (PBX).** A private telephone exchange for transmission of calls to and from the public telephone network.

**problem determination.** The process of determining the source of a problem; for example, a program component, machine failure, telecommunication facilities, user or contractor-installed programs or equipment, environmental failure such as a power loss, or user error.

**program temporary fix (PTF).** A temporary solution or bypass of a problem diagnosed by IBM in a current unaltered release of the program.

**protocol.** (1) A set of semantic and syntactic rules that determine the behavior of functional units in achieving communication. (I) (2) In Open Systems Interconnection architecture, a set of semantic and syntactic rules that determine the behavior of entities in the same layer in performing communication functions. (T) (3) In SNA, the meanings of, and the sequencing rules for, requests and responses used for managing the network, transferring data, and synchronizing the states of network components.

Synonymous with *line control discipline* and *line discipline*. See *bracket protocol* and *link protocol*.

**protocol data unit (PDU).** A unit of data specified in a protocol of a given layer and consisting of protocol control information of this layer, and possibly user data of this layer. (T)

**pulse code modulation (PCM).** A standard adopted for the digitalization of an analog voice signal. In PCM, the voice is sampled at a rate of eight kHz and each sample is coded in an 8-bit frame.

## R

**Rapid Transport Protocol (RTP) connection.** In high-performance routing (HPR), the connection established between the endpoints of the route to transport session traffic.

**reachability.** The ability of a node or a resource to communicate with another node or resource.

**read-only memory (ROM).** Memory in which stored data cannot be modified by the user except under special conditions.

**real-time processing.** The manipulation of data that are required, or generated, by some process while the process is in operation. Usually the results are used to influence the process, and perhaps related processes, while it is occurring.

**reassembly.** In communications, the process of putting segmented packets back together after they have been received.

**receive not ready (RNR).** In communications, a data link command or response that indicates a temporary condition of being unable to accept incoming frames.

**receive not ready (RNR) packet.** See *RNR packet*.

**received line signal detector (RLSD).** In the EIA 232 standard, a signal that indicates to the data terminal equipment (DTE) that it is receiving a signal from the remote data circuit-terminating equipment (DCE). Synonymous with *carrier detect* and *data carrier detect (DCD)*.

**Recognized Private Operating Agency (RPOA).** Any individual, company, or corporation, other than a government department or service, that operates a telecommunication service and is subject to the obligations undertaken in the Convention of the International Telecommunication Union and in the Regulations; for example, a communication common carrier.

**reduced instruction-set computer (RISC).** A computer that uses a small, simplified set of frequently used instructions for rapid execution.

**remote.** (1) Pertaining to a system, program, or device that is accessed through a telecommunication line. (2) Synonym for *link-attached*. (3) Contrast with *local*.

**remote bridging.** The function of a bridge that allows two bridges to connect multiple LANs using a telecommunication link. Contrast with *local bridging*.

**remote console.** A station running OS/2, TCP/IP, and the remote Nways Switch Resource Control program. It can be connected to any network support station to operate and service the Nways Switch remotely.

The connection may be through:

- A switched line using a modem

Any network support station can be used as a remote console of another network support station.

**Remote Execution Protocol (REXEC).** A protocol that allows the execution of a command or program on any host in the network. The local host receives the results of the command execution.

**Request for Comments (RFC).** In Internet communications, the document series that describes a part of the Internet suite of protocols and related experiments. All Internet standards are documented as RFCs.

**reset.** On a virtual circuit, reinitialization of data flow control. At reset, all data in transit are eliminated.

**reset request packet.** In X.25 communications, a packet transmitted by the data terminal equipment (DTE) to the data circuit-terminating equipment (DCE) to request that a virtual call or a permanent virtual circuit be reset. The reason for the request can also be specified in the packet.

**resource.** In the Nways Switch, an hardware element or a logical entity created by the Control Program. For example, the adapters, LICs, and lines are physical resources. The control points and connections are logical resources.

**ring.** See *ring network*.

**ring network.** (1) A network in which every node has exactly two branches connected to it and in which there are exactly two paths between any two nodes. (T) (2) A network configuration in which devices are connected by unidirectional transmission links to form a closed path.

**ring segment.** A section of a ring that can be isolated (by unplugging connectors) from the rest of the ring. See *LAN segment*.

**rlogin (remote login).** A service, offered by Berkeley UNIX-based systems, that allows authorized users of one machine to connect to other UNIX systems across an internet and interact as if their terminals were connected directly. The rlogin software passes



information about the user's environment (for example, terminal type) to the remote machine.

**RNR packet.** A packet used by a data terminal equipment (DTE) or by a data circuit-terminating equipment (DCE) to indicate a temporary inability to accept additional packets for a virtual call or permanent virtual circuit.

**root bridge.** The bridge that is the root of a spanning tree formed between other active bridges in the bridging network. The root bridge originates and transmits bridge protocol data units (BPDUs) to other active bridges to maintain the spanning tree topology. It is the bridge with the highest priority in the network.

**route.** (1) An ordered sequence of nodes and transmission groups (TGs) that represent a path from an origin node to a destination node traversed by the traffic exchanged between them. (2) The path that network traffic uses to get from source to destination.

**route bridge.** A function of an IBM bridge program that allows two bridge computers to use a telecommunication link to connect two LANs. Each bridge computer is connected directly to one of the LANs, and the telecommunication link connects the two bridge computers.

**route extension (REX).** In SNA, the path control network components, including a peripheral link, that make up the portion of a path between a subarea node and a network addressable unit (NAU) in an adjacent peripheral node. See also *explicit route (ER)*, *path*, and *virtual route (VR)*.

**Route Selection control vector (RSCV).** A control vector that describes a route within an APPN network. The RSCV consists of an ordered sequence of control vectors that identify the TGs and nodes that make up the path from an origin node to a destination node.

**router.** (1) A computer that determines the path of network traffic flow. The path selection is made from several paths based on information obtained from specific protocols, algorithms that attempt to identify the shortest or best path, and other criteria such as metrics or protocol-specific destination addresses. (2) An attaching device that connects two LAN segments, which use similar or different architectures, at the reference model network layer. (3) In OSI terminology, a function that determines a path by which an entity can be reached. (4) In TCP/IP, synonymous with *gateway*. (5) Contrast with *bridge*.

**routing.** (1) The assignment of the path by which a message is to reach its destination. (2) In SNA, the forwarding of a message unit along a particular path through a network, as determined by parameters carried in the message unit, such as the destination network address in a transmission header.

**routing domain.** In Internet communications, a group of intermediate systems that use a routing protocol so that the representation of the overall network is the same within each intermediate system. Routing domains are connected to each other by exterior links.

**Routing Information Protocol (RIP).** In the Internet suite of protocols, an interior gateway protocol used to exchange intradomain routing information and to determine optimum routes between internet hosts. RIP determines optimum routes on the basis of route metrics, not link transmission speed.

**routing loop.** A situation that occurs when routers circulate information among themselves until convergence occurs or until the networks involved are considered unreachable.

**routing protocol.** A technique used by a router to find other routers and to remain up to date about the best way to get to reachable networks.

**routing table.** A collection of routes used to direct datagram forwarding or to establish a connection. The information is passed among routers to identify network topology and destination feasibility.

**Routing Table Maintenance Protocol (RTMP).** In AppleTalk networks, a protocol that provides routing information generation and maintenance on the transport layer by means of the AppleTalk routing table. The AppleTalk routing table directs packet transmission through the internet from source socket to destination socket.

**Routing update Protocol (RTP).** The Virtual NEtworking System (VINES) protocol that maintains the routing database and allows the exchange of routing information between VINES nodes. See also *Internet Control Protocol (ICP)*.

**rsh.** A variant of the rlogin command that invokes a command interpreter on a remote UNIX machine and passes the command-line arguments to the command interpreter, skipping the login step completely.

## S

**SAP.** See service access point.

**seed router.** In AppleTalk networks, a router that maintains configuration data (network range numbers and zone lists, for example) for the network. Each network must have at least one seed router. The seed router must be initially set up using the configurator tool. Contrast with *nonseed router*.

**segment.** (1) A section of cable between components or devices. A segment may consist of a single patch cable, several patch cables that are connected, or a combination of building cable and patch cables that are connected. (2) In Internet communications, the unit of

transfer between TCP functions in different machines. Each segment contains control and data fields; the current byte-stream position and actual data bytes are identified along with a checksum to validate received data.

**segmenting.** In OSI, a function performed by a layer to map one protocol data unit (PDU) from the layer it supports into multiple PDUs.

**sequence number.** In communications, a number assigned to a particular frame or packet to control the transmission flow and receipt of data.

**Serial Line Internet Protocol (SLIP).** A protocol used over a point-to-point connection between two IP hosts over a serial line, for example, a serial cable or an RS232 connection into a modem, over a telephone line.

**server.** A functional unit that provides shared services to workstations over a network; for example, a file server, a print server, a mail server. (T)

**service access point (SAP).** (1) In Open Systems Interconnection (OSI) architecture, the point at which the services of a layer are provided by an entity of that layer to an entity of the next higher layer. (T) (2) A logical point made available by an adapter where information can be received and transmitted. A single service access point can have many links terminating in it.

**Service Advertising Protocol (SAP).** In Internetwork Packet Exchange (IPX), a protocol that provides the following:

- A mechanism that allows IPX servers on an internet to advertise their services by name and type. Servers using this protocol have their name, service type, and address recorded in all file servers running NetWare.
- A mechanism that allows a workstation to broadcast a query to discover the identities of all servers of all types, all servers of a specific type, or the nearest server of a specific type.
- A mechanism that allows a workstation to query any file server running NetWare to discover the names and addresses of all servers of a specific type.

**session.** (1) In network architecture, for the purpose of data communication between functional units, all the activities which take place during the establishment, maintenance, and release of the connection. (T) (2) A logical connection between two network accessible units (NAUs) that can be activated, tailored to provide various protocols, and deactivated, as requested. Each session is uniquely identified in a transmission header (TH) accompanying any transmissions exchanged during the session. (3) In L2TP, L2TP creates a session when an end-to-end PPP connection is attempted between a dial user and the LNS; regardless of whether the user initiates the session or the LNS initiates an outbound call. The datagrams for the session are sent

over the tunnel between the LAC and LNS. The LNS and LAC maintain the state information for each user attached to an LAC.

**Simple Network Management Protocol (SNMP).** In the Internet suite of protocols, a network management protocol that is used to monitor routers and attached networks. SNMP is an application layer protocol. Information on devices managed is defined and stored in the application's Management Information Base (MIB).

**SNA management services (SNA/MS).** The services provided to assist in management of SNA networks.

**socket.** (1) An endpoint for communication between processes or application programs. (2) The abstraction provided by the University of California's Berkeley Software Distribution (commonly called Berkeley UNIX or BSD UNIX) that serves as an endpoint for communication between processes or applications.

**source route bridging.** In LANs, a bridging method that uses the routing information field in the IEEE 802.5 medium access control (MAC) header of a frame to determine which rings or token-ring segments the frame must transit. The routing information field is inserted into the MAC header by the source node. The information in the routing information field is derived from explorer packets generated by the source host.

**source routing.** In LANs, a method by which the sending station determines the route the frame will follow and includes the routing information with the frame. Bridges then read the routing information to determine whether they should forward the frame.

**source service access point (SSAP).** In SNA and TCP/IP, a logical address that allows a system to send data to a remote device from the appropriate communications support. Contrast with *destination service access point (DSAP)*.

**spanning tree.** In LAN contexts, the method by which bridges automatically develop a routing table and update that table in response to changing topology to ensure that there is only one route between any two LANs in the bridged network. This method prevents packet looping, where a packet returns in a circuitous route back to the sending router.

**sphere of control (SOC).** The set of control point domains served by a single management services focal point.

**sphere of control (SOC) node.** A node directly in the sphere of control of a focal point. A SOC node has exchanged management services capabilities with its focal point. An APPN end node can be a SOC node if it supports the function to exchange management services capabilities.

**split horizon.** A technique for minimizing the time to achieve network convergence. A router records the interface over which it received a particular route and does not propagate its information about the route back over the same interface.

**spoofing.** For data links, a technique in which a protocol initiated from an end station is acknowledged and processed by an intermediate node on behalf of the final destination. In IBM 6611 data link switching, for example, SNA frames are encapsulated into TCP/IP packets for transport across a non-SNA wide area network, unpacked by another IBM 6611, and passed to the final destination. A benefit of spoofing is the prevention of end-to-end session timeouts.

**standard MIB.** In the Simple Network Management Protocol (SNMP), a MIB module that is located under the management branch of the Structure of Management Information (SMI) and that is considered a standard by the Internet Engineering Task Force (IETF).

**static route.** The route between hosts, networks, or both that is manually entered into a routing table.

**station.** An input or output point of a system that uses telecommunication facilities; for example, one or more systems, computers, terminals, devices, and associated programs at a particular location that can send or receive data over a telecommunication line.

**StreetTalk.** In the Virtual NETworking System (VINES), a unique network-wide naming and addressing system that allows users to locate and access any resource on the network without knowing the network topology. See also *Internet Control Protocol (ICP)* and *RouTing update Protocol (RTP)*.

**Structure of Management Information (SMI).** (1) In the Simple Network Management Protocol (SNMP), the rules used to define the objects that can be accessed by means of a network management protocol. (2) In OSI, the set of standards relating to management information. The set includes the *Management Information Model* and the *Guidelines for the Definition of Managed Objects*

**subarea.** A portion of the SNA network consisting of a subarea node, attached peripheral nodes, and associated resources. Within a subarea node, all network accessible units (NAUs), links, and adjacent link stations (in attached peripheral or subarea nodes) that are addressable within the subarea share a common subarea address and have distinct element addresses.

**subnet.** (1) In TCP/IP, a part of a network that is identified by a portion of the IP address. (2) Synonym for *subnetwork*.

**subnet address.** In Internet communications, an extension to the basic IP addressing scheme where a portion of the host address is interpreted as the local network address.

**subnet mask.** Synonym for *address mask*.

**subnetwork.** (1) Any group of nodes that have a set of common characteristics, such as the same network ID. (2) Synonymous with *subnet*.

**Subnetwork Access Protocol (SNAP).** In LANs, a 5-byte protocol discriminator that identifies the non-IEEE standard protocol family to which a packet belongs. The SNAP value is used to differentiate between protocols that use \$AA as their service access point (SAP) value.

**subnetwork mask.** Synonym for *address mask*.

**subsystem.** A secondary or subordinate system, usually capable of operating independently of, or asynchronously with, a controlling system. (T)

**switched virtual circuit (SVC).** An X.25 circuit that is dynamically established when needed. The X.25 equivalent of a switched line. Contrast with *permanent virtual circuit (PVC)*.

**synchronous.** (1) Pertaining to two or more processes that depend upon the occurrence of specific events such as common timing signals. (T) (2) Occurring with a regular or predictable time relationship.

**Synchronous Data Link Control (SDLC).** (1) A discipline conforming to subsets of the Advanced Data Communication Control Procedures (ADCCP) of the American National Standards Institute (ANSI) and High-level Data Link Control (HDLC) of the International Organization for Standardization, for managing synchronous, code-transparent, serial-by-bit information transfer over a link connection. Transmission exchanges may be duplex or half-duplex over switched or nonswitched links. The configuration of the link connection may be point-to-point, multipoint, or loop. (I) (2) Contrast with *binary synchronous communication (BSC)*.

**synchronous optical network (SONET).** A US standard for transmitting digital information over optical interfaces. It is closely related to the synchronous digital hierarchy (SDH) recommendation.

**SYNTAX.** In the Simple Network Management Protocol (SNMP), a clause in the MIB module that defines the abstract data structure that corresponds to a managed object.

**system.** In data processing, a collection of people, machines, and methods organized to accomplish a set of specific functions. (I) (A)

**system configuration.** A process that specifies the devices and programs that form a particular data processing system.

**system services control point (SSCP).** A component within a subarea network for managing the configuration, coordinating network operator and problem determination requests, and providing directory services and other session services for users of the network. Multiple SSCPs, cooperating as peers with one another, can divide the network into domains of control, with each SSCP having a hierarchical control relationship to the physical units and logical units within its own domain.

**Systems Network Architecture (SNA).** The description of the logical structure, formats, protocols, and operational sequences for transmitting information units through, and controlling the configuration and operation of, networks. The layered structure of SNA allows the ultimate origins and destinations of information, that is, the users, to be independent of and unaffected by the specific SNA network services and facilities used for information exchange.

## T

**TCP/IP.** (1) Transmission Control Protocol/Internet Protocol. (2) A UNIX-like/Ethernet-based system-interconnect protocol originally developed by the US Department of Defense. TCP/IP facilitated ARPANET (Advanced Research Projects Agency Network), a packet-switched research network for which Layer 4 was TCP and Layer 3, IP.

**Telnet.** In the Internet suite of protocols, a protocol that provides remote terminal connection service. It allows users of one host to log on to a remote host and interact as directly attached terminal users of that host.

**threshold.** (1) In IBM bridge programs, a value set for the maximum number of frames that are not forwarded across a bridge due to errors, before a "threshold exceeded" occurrence is counted and indicated to network management programs. (2) An initial value from which a counter is decremented to 0, or a value to which a counter is incremented or decremented from an initial value.

**throughput class.** In packet switching, the speed at which data terminal equipment (DTE) packets travel through the packet switching network.

**time division multiplexing (TDM).** See *channelization*.

**time to live (TTL).** A technique used by best-effort delivery protocols to inhibit endlessly looping packets. The packet is discarded if the TTL counter reaches 0.

**timeout.** (1) An event that occurs at the end of a predetermined period of time that began at the

occurrence of another specified event. (l) (2) A time interval allotted for certain operations to occur; for example, response to polling or addressing before system operation is interrupted and must be restarted.

**token.** (1) In a local area network, the symbol of authority passed successively from one data station to another to indicate the station temporarily in control of the transmission medium. Each data station has an opportunity to acquire and use the token to control the medium. A token is a particular message or bit pattern that signifies permission to transmit. (T) (2) In LANs, a sequence of bits passed from one device to another along the transmission medium. When the token has data appended to it, it becomes a frame.

**token ring.** (1) According to IEEE 802.5, network technology that controls media access by passing a token (special packet or frame) between media-attached stations. (2) A FDDI or IEEE 802.5 network with a ring topology that passes tokens from one attaching ring station (node) to another. (3) See also *local area network (LAN)*.

**token-ring network.** (1) A ring network that allows unidirectional data transmission between data stations, by a token passing procedure, such that the transmitted data return to the transmitting station. (T) (2) A network that uses a ring topology, in which tokens are passed in a circuit from node to node. A node that is ready to send can capture the token and insert data for transmission.

**topology.** In communications, the physical or logical arrangement of nodes in a network, especially the relationships among nodes and the links between them.

**topology database update (TDU).** A message about a new or changed link or node that is broadcast among APPN network nodes to maintain the network topology database, which is fully replicated in each network node. A TDU contains information that identifies the following:

- The sending node
- The node and link characteristics of various resources in the network
- The sequence number of the most recent update for each of the resources described.

**trace.** (1) A record of the execution of a computer program. It exhibits the sequences in which the instructions were executed. (A) (2) For data links, a record of the frames and bytes transmitted or received.

**transceiver (transmitter-receiver).** In LANs, a physical device that connects a host interface to a local area network, such as Ethernet. Ethernet transceivers contain electronics that apply signals to the cable and that sense collisions.

**Transmission Control Protocol (TCP).** A communications protocol used in the Internet and in any



network that follows the U.S. Department of Defense standards for internetwork protocol. TCP provides a reliable host-to-host protocol between hosts in packet-switched communications networks and in interconnected systems of such networks. It uses the Internet Protocol (IP) as the underlying protocol.

**Transmission Control Protocol/Internet Protocol (TCP/IP).** A set of communications protocols that support peer-to-peer connectivity functions for both local and wide area networks.

**transmission group (TG).** (1) A connection between adjacent nodes that is identified by a transmission group number. (2) In a subarea network, a single link or a group of links between adjacent nodes. When a transmission group consists of a group of links, the links are viewed as a single logical link, and the transmission group is called a *multilink transmission group (MLTG)*. A *mixed-media multilink transmission group (MMMLTG)* is one that contains links of different medium types (for example, token-ring, switched SDLC, nonswitched SDLC, and frame-relay links). (3) In an APPN network, a single link between adjacent nodes. (4) See also *parallel transmission groups*.

**transmission header (TH).** Control information, optionally followed by a basic information unit (BIU) or a BIU segment, that is created and used by path control to route message units and to control their flow within the network. See also *path information unit*.

**transparent bridging.** In LANs, a method for tying individual local area networks together through the medium access control (MAC) level. A transparent bridge stores the tables that contain MAC addresses so that frames seen by the bridge can be forwarded to another LAN if the tables indicate to do so.

**transport layer.** In the Open Systems Interconnection reference model, the layer that provides a reliable end-to-end data transfer service. There may be relay open systems in the path. (T) See also *Open Systems Interconnection reference model*.

**trap.** In the Simple Network Management Protocol (SNMP), a message sent by a managed node (agent function) to a management station to report an exception condition.

**trunk line.** A high-speed line connecting two Nways Switches. It can be a coaxial cable, fiber cable, or radio wave, for example, and may be leased from telecommunication companies.

**Tunnel.** A tunnel is defined by an LNS-LAC pair. The tunnel carries PPP datagrams between the LAC and the LNS. A single tunnel can multiplex many sessions. A control connection operating over the same tunnel controls the establishment, release, and maintenance of all sessions and of the tunnel itself.

**tunneling.** To treat a transport network as though it were a single communication link or LAN. See also *encapsulation*.

**T1.** In the United States, a 1.544-Mbps public access line. It is available in twenty-four 64-Kbps channels. The European version (E1) transmits 2.048 Mbps.

## U

**universally administered address.** In a local area network, the address permanently encoded in an adapter at the time of manufacture. All universally administered addresses are unique. Contrast with *locally administered address*.

**User Datagram Protocol (UDP).** In the Internet suite of protocols, a protocol that provides unreliable, connectionless datagram service. It enables an application program on one machine or process to send a datagram to an application program on another machine or process. UDP uses the Internet Protocol (IP) to deliver datagrams.

## V

**V.24.** In data communication, a specification of the CCITT that defines the list of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE).

**V.25.** In data communication, a specification of the CCITT that defines the automatic answering equipment and parallel automatic calling equipment on the General Switched Telephone Network, including procedures for disabling of echo controlled devices for both manually and automatically established calls.

**V.34.** An ITU-T Recommendation for modem communication over standard commercially available voice-grade 33.6-Kbps (and slower) channels.

**V.35.** In data communication, a specification of the CCITT that defines the list of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) at various data rates.

**V.36.** In data communication, a specification of the CCITT that defines the list of definitions for interchange circuits between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) at rates of 48, 56, 64, or 72 kilobits per second.

**version.** A separately licensed program that usually has significant new code or new function.

**VINES.** Virtual NEtworking System.

**virtual circuit.** (1) In packet switching, the facilities provided by a network that give the appearance to the user of an actual connection. (T) See also *data*

*circuit*. Contrast with *physical circuit*. (2) A logical connection established between two DTEs.

**virtual connection.** In frame relay, the return path of a potential connection.

**virtual link.** In Open Shortest Path First (OSPF), a point-to-point interface that connects border routers that are separated by a non-backbone transit area. Because area routers are part of the OSPF backbone, the virtual link connects the backbone. The virtual links ensure that the OSPF backbone does not become discontinuous.

**Virtual Networking System (VINES).** The network operating system and network software from Banyan Systems, Inc. In a VINES network, virtual linking allows all devices and services to appear to be directly connected to each other, when they may actually be thousands of miles apart. See also *StreetTalk*.

**virtual route (VR).** (1) In SNA, either (a) a logical connection between two subarea nodes that is physically realized as a particular explicit route or (b) a logical connection that is contained wholly within a subarea node for intranode sessions. A virtual route between distinct subarea nodes imposes a transmission priority on the underlying explicit route, provides flow control through virtual route pacing, and provides data integrity through sequence numbering of path information units (PIUs). (2) Contrast with *explicit route (ER)*. See also *path* and *route extension (REX)*.

## W

**wide area network (WAN).** (1) A network that provides communication services to a geographic area larger than that served by a local area network or a metropolitan area network, and that may use or provide public communication facilities. (T) (2) A data communication network designed to serve an area of hundreds or thousands of miles; for example, public and private packet-switching networks, and national telephone networks. (3) Contrast with *local area network (LAN)* and *metropolitan area network (MAN)*.

**wildcard character.** Synonym for *pattern-matching character*.

## X

**X.21.** An International Telegraph and Telephone Consultative Committee (CCITT) recommendation for a general-purpose interface between data terminal equipment and data circuit-terminating equipment for synchronous operations on a public data network.

**X.25.** (1) An International Telegraph and Telephone Consultative Committee (CCITT) recommendation for the interface between data terminal equipment and packet-switched data networks. (2) See also *packet switching*.

**Xerox Network Systems (XNS).** The suite of internet protocols developed by the Xerox Corporation. Although similar to TCP/IP protocols, XNS uses different packet formats and terminology. See also *Internetwork Packet Exchange (IPX)*.

## Z

**zone.** In AppleTalk networks, a subset of nodes within an internet.

**Zone Information Protocol (ZIP).** In AppleTalk networks, a protocol that provides zone management service by maintaining a mapping of the zone names and network numbers across the internet on the session layer.

**zone information table (ZIT).** A listing of network numbers and their associated zone name mappings in the internet. This listing is maintained by each internet router in an AppleTalk internet.

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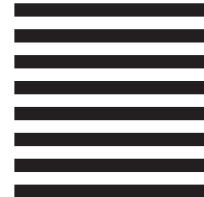
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