Access Integration Services

Using and Configuring Features Version 3.2

SC30-3989-00

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Note
Before using this document, read the general information under “Notices” on page xv.

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This edition applies to Version 3.2 of the IBM Access Integration Services and to all subsequent releases and modifications until otherwise indicated in new editions or technical newsletters.

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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 features installed on your IBM 2212. A specific IBM 2212 might not support all of the features described in this manual. If a feature is device-specific, you are informed of that by:

- A notice in the relevant chapter or section
- A section in the preface that lists the features and the devices that support them

This manual supports the IBM 2212 and refers to it as either a “router” or a “device”. The examples in the manual represent the configuration of an IBM 2212, 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.

To get 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 diskette 1 of the configuration program diskettes. You can view the file with an ASCII text editor.

About the Software

IBM Access Integration Services is the software that supports the IBM 2212 (licensed program number 5639-F73). 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 Access Integration 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 2212.
- The Configuration Program for IBM Access Integration 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 Access Integration Services from the IBM Networking Technical Support home page. See *Configuration Program User’s Guide for Multiprotocol and Access Services Products,* 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 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

The following list shows the books in the IBM 2212 library, arranged according to tasks.

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 2212 home pages at:

```
http://www.networking.ibm.com/2212/2212prod.html
```

Planning

GA27-4215
IBM 2212 Introduction and Planning Guide

This book is shipped with the IBM 2212. It explains how to prepare for installation and perform an initial configuration.

Installation

GA27-4216
IBM 2212 Access Utility Installation and Initial Configuration Guide

This booklet is shipped with the IBM 2212. It explains how to install the IBM 2212 and verify its installation.

GX27-4048
2212 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 2212.

Diagnostics and Maintenance

GY27-0362
IBM 2212 Access Utility Service and Maintenance Manual

This book is shipped with the IBM 2212. It provides instructions for diagnosing problems with and repairing the IBM 2212.

Operations and Network Management

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

SC30-3988
Software User's Guide

This book explains how to:

- Configure, monitor, and use the Access Integration Services software.
- Use the Access Integration Services command-line router user interface to configure and monitor the network interfaces and link-layer protocols shipped with the IBM 2212.

SC30-3989
Using and Configuring Features

SC30-3990
Protocol Configuration and Monitoring Reference Volume 1

SC30-3991
Protocol Configuration and Monitoring Reference Volume 2

These books describe how to access and use the Access Integration 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 Multiprotocol and Access Services Products

This book discusses how to use the Configuration Program.

Safety

SD21-0030

Caution: Safety Information—Read This First

This book, shipped with the IBM 2212, provides translations of caution and danger notices applicable to the installation and maintenance of a IBM 2212.

Marketing

URL: **http://www.networking.ibm.com/2212/2212prod.html**

This IBM Web page provides product information through the World Wide Web.

Summary of Changes for the IBM 2212 Software Library

The IBM 2212 is a new product; however, it uses common code. The following list applies to changes in the common code that were made in Version 3.2.

- **New functions:**
  - IP Version 6
    - TCP6, UDP6, Telnet, PING-6 and traceroute-6, ICMPv6, and IPsec
    - Neighbor discovery protocol (NDP) for host auto-configuration
    - Static routes, RIPng, Protocol Independent Multicast-Dense Mode (PIM-DM), and Multicast Listener Discovery (MLD)
    - Configured or automatic tunneling of IPv6 packets over IPv4 networks
  - Resource ReSerVation Protocol (RSVP)
    - Signalling mechanisms that enable applications on IPv4 networks to reserve network resources to achieve a desired quality of service for packet delivery
  - Thin Server Support
    - Acts as boot server for network stations
    - Servers supported include Network Station Manager (NSM) R2.5 and 3.0 on OS/400 and NSM R3.0 for NFS servers such as Windows NT, OS/390, AIX, and VM
  - Binary Synchronous Relay (BRLY) support for BSC interfaces

    Binary Synchronous Relay (BRLY) support for tunneling Bisync Synchronous (BSC) transmissions over a IPv4 network to a partner 2210 or 2212 router
- **Enhanced functions:**
  - Base Services
    - Event Logging System (ELS) enhancements to capture, format, and offload large volumes of ELS messages
    - Support for maintaining multiple, compressed dump files
    - Timed configuration change support from the configuration tool that is persistent across reloads and restarts

- Packet trace support for PPP, Frame Relay, and V.34 interfaces.

– Bridging support for a multiaccess bridge port for source route bridging over Frame Relay. The multiaccess port incorporates many DLCIs in a single bridge port for improved scalability.
– DIALs
  - DIALs support for functions supported by Microsoft Dial-Up Network Clients
    • Support for Callback Control Protocol (CBCP)
    • Support for Microsoft Point-to-Point Encryption (MPPE) and Microsoft PPP CHAP (MS-CHAP)
  - Virtual connections to suspend and resume dial-up connections when Shiva Password Authentication Protocol (SPAP) is used
– IP items
  - IP precedence/TOS filter enhancements
  - Policy-based routing
  - Configuration of the IP MTU by interface
  - OSPF Enhancements to allow for easier migration of IBM 6611 router networks
  - BGP-4 support for policies per neighbor and additional attributes for path selection
  - DVMRPv3 support
  - IGMP prune and grafting support
– ISDN support for callback based on the caller ID and call blocking
– L2TP support for the L2TP client model which allows the 2212 to create an L2TP tunnel between itself and another router. The tunnel can be used for any traffic entering the 2212. The L2TP Network Server (LNS) function has also been enhanced to initiate outgoing calls to the L2TP Network Access Concentrator (LAC).
– Network Dispatcher items
  - Support for stateless UDP applications
  - New protocol advisors for Network News Transfer Protocol (NNTP), Post Office Protocol (POP3), Simple Mail Transfer Protocol (SMTP), and Telnet
  - While you are balancing TN3270 servers, one of the TN3270 servers may be in the same 2212 as the Network Dispatcher function
– Support for PPP authentication using an ACE/Server
– Security Enhancements
  - IPsec tunnel-in-tunnel support for creating up to two nested levels of security associations
  - IPsec ESP NULL algorithm support
  - IPsec support for setting the *don't fragment* bit and propogation of Path MTU
  - Improved dynamic reconfiguration for IPsec
– Mixed media multi-link PPP support for bundling PPP leased line, ISDN, V.25bis, and V.34 connections
– APPN enhancements
  - APPN SDLC Secondary multipoint support
  - Configuration of the APPN transmission group (TG) number for all link station types
  - Support for the APPN Ping (APING) command in Talk 5

- New trace options

– TN3270 Enhancements

Note: These TN3270 enhancements will not be available in the initial release of V3.2, but will be available on the 2212 Web server by 12/31/98.

- TN3270 LU pooling support that allows SNA LUs to be grouped into named pools
- TN3270 IP address to LU name mapping
- Self-Defining Dependent LUs (SDDLU) and Dynamically Defined Dependent LUs (DDDLU) support
- Multiple TCP port support

– DLSw enhancements

- Support for duplicate MAC addresses
- Support to delay polling of SDLC devices until contacted by the remote SDLC device

– X.25 enhancements

- Configuration support for a defining a range of PVCs
- Support for up to 2500 PVCs

– Frame Relay support for switched virtual circuits

– IPXWAN support on Frame Relay permanent virtual circuits (PVCs), including support for numbered RIP, unnumbered RIP, and static routing

- **Clarifications and corrections**

  The technical changes and additions are indicated by a vertical line (|) to the left of the change.

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. For example, the following information appears if you enter **?** at the * prompt:

```
*?

DIAGS hardware diagnostics
DIVERT output from process
FLUSH output from process
HALT output from process
INTERCEPT character is
LOGOUT
MEMORY statistics
RELOAD
RESTART

STATUS of process(es)
TALK to process
TELNET to IP-Address
```

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 2212. 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 IP protocol configuration process:

```
IP config> exit
Config>
```

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

Summary of Changes

Chapter 1. Using Bandwidth Reservation and Priority Queuing

This chapter describes the Bandwidth Reservation System and priority queuing features currently available for Frame Relay and PPP interfaces. It includes the following sections:

Bandwidth Reservation System

The Bandwidth Reservation System (BRS) allows you to decide which packets to drop when demand (traffic) exceeds supply (throughput) on a network connection. When bandwidth utilization reaches 100%, BRS determines which traffic to drop based on your configuration.

Bandwidth reservation ″reserves″ transmission bandwidth for specified classes of traffic. Each class has an allocated minimum percentage of the connection's bandwidth. See Figure 1 on page 2 and Figure 2 on page 2.

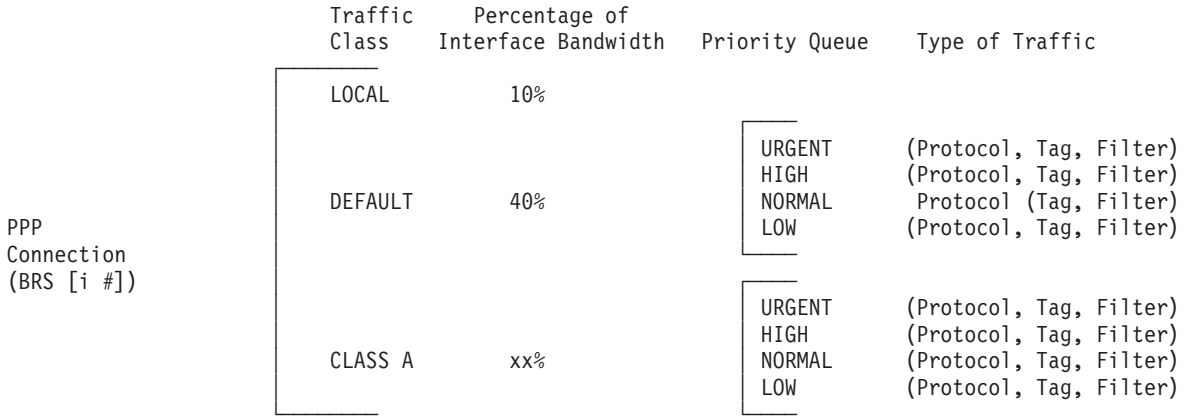
On PPP interfaces, you define traffic classes (t-classes) and each traffic class is allocated a percentage of the PPP interface's bandwidth. There are at least two traffic classes:

1. A LOCAL class which is allocated bandwidth for packets that are locally originated by the router (e.g. IP RIP packets)
2. A DEFAULT class to which all other traffic is initially assigned.

You can create additional traffic classes and assign protocols, filters and tags to the priority queues within a traffic class. See Figure 1 on page 2.

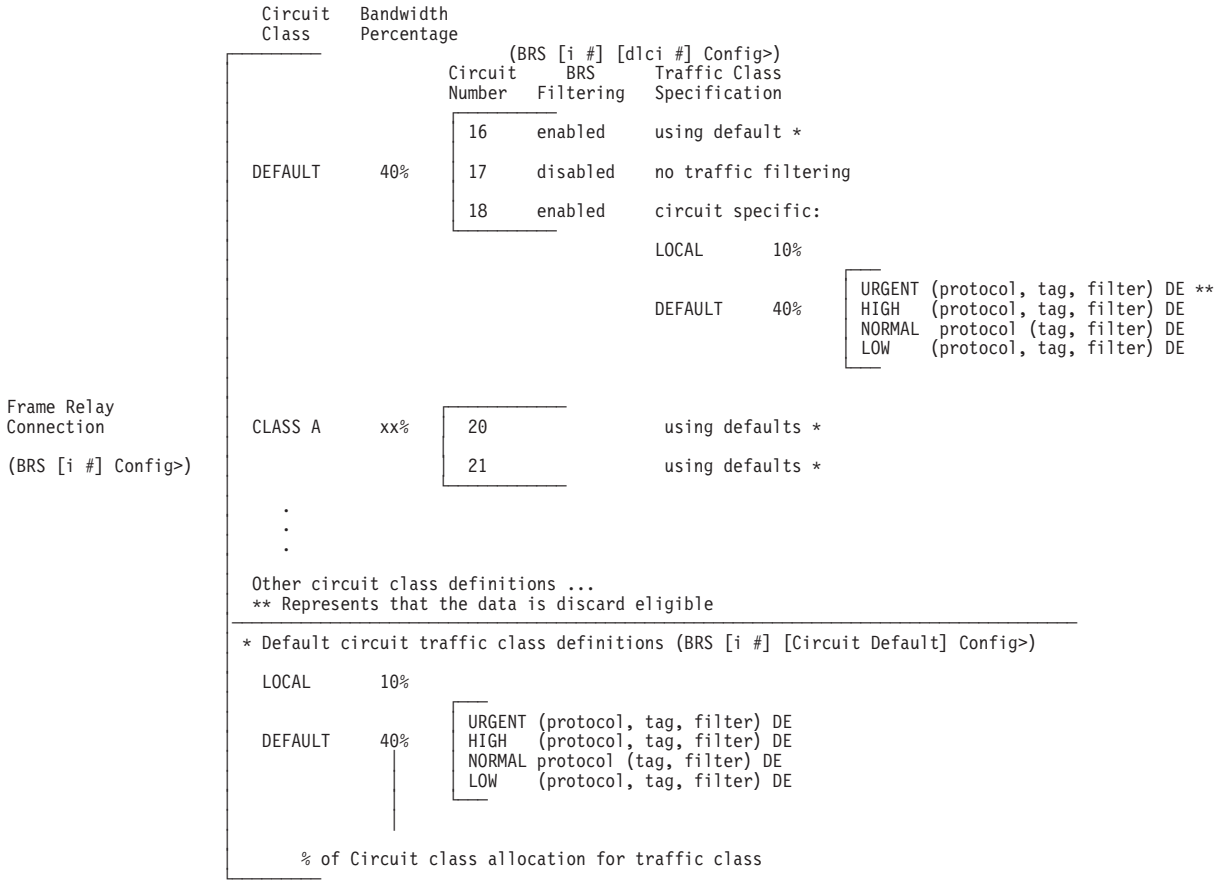
On Frame Relay interfaces, you define circuit classes (c-classes) and each circuit class is allocated a percentage of the Frame Relay interface's bandwidth. There is at least one circuit class: the DEFAULT circuit class to which all circuits are initially assigned. You can create additional circuit classes and assign circuits to these c-classes. On each Frame Relay circuit, you can define traffic classes (t-classes) and each traffic class is allocated a percentage of the Frame Relay circuit's bandwidth. The traffic class support for Frame Relay circuits is analogous to the traffic class support for PPP interfaces. See Figure 2 on page 2 for the Frame Relay Circuit Class and Traffic Class Relationships.

Using BRS and Priority Queuing



Note: All protocols are initially assigned to the NORMAL priority queue of the DEFAULT traffic class. You can assign a protocol, filter, or tag to any priority queue within a traffic class.

Figure 1. PPP BRS Traffic Class and Traffic Class Priority Queue Relationship



Note: All protocols are initially assigned to the NORMAL priority queue of the DEFAULT traffic class. You can assign a protocol, filter, or tag to any priority queue within a traffic class.

Figure 2. Frame Relay BRS Circuit Class and Traffic Class Relationship

These reserved percentages are a minimum *slice* of bandwidth for the network connection. If a network is operating to capacity, messages in any one class can be

transmitted only until they use the configured bandwidth allocated for the class. In this case, additional transmissions are held until other bandwidth transmissions have been satisfied. In the case of a light traffic path, a packet stream can use bandwidth exceeding its allowed minimum up to 100% if there is no other traffic.

Bandwidth reservation is really a *safeguard*. In general, a device should not attempt to use greater than 100% of its line speed. If it does, a faster line is probably needed. The “bursty” nature of traffic, however, can drive the requested transmission rate to exceed 100% for a short time. In these cases, bandwidth reservation is enabled and the higher priority traffic is ensured delivery (that is, is not discarded).

Bandwidth reservation runs over the following connection types:

- Frame Relay (serial line or dial circuit interface)
- PPP (serial line or dial circuit interface)

Bandwidth Reservation over Frame Relay

Bandwidth reservation allows you to reserve bandwidth at two levels:

- At the interface level, you can assign a percentage of the interface’s bandwidth to circuit classes (*c-classes*). Each circuit class contains one or more circuits.
- At the circuit level, you can define traffic classes and allocate a percentage of the circuit’s bandwidth.

Packets are filtered and queued into BRS t-classes based on the packet’s protocol type and any configured BRS filters. The packets are then queued into a BRS c-class based on the DLCI number.

The actual amount of bandwidth available for bandwidth reservation depends upon how you configure the interface and circuit:

- If you enable Frame Relay CIR monitoring, the bandwidth available to the circuit is allocated strictly according to its committed information rate (CIR), its committed burst size, and its excess burst size.
- If you disable CIR monitoring, up to 100 % of the bandwidth of the interface may be available to a circuit.

Orphaned circuits and circuits without BRS explicitly enabled use a default BRS queuing environment where the packets are queued on the default t-class and priority and the default c-class.

You can use several bandwidth reservation monitoring commands to display reservation counters for the circuit classes for a given interface:

- clear-circuit-class
- counters-circuit-class
- last-circuit-class

See “Chapter 2. Configuring and Monitoring Bandwidth Reservation” on page 19 for more information on monitoring BRS.

The interface is the one shown at your prompt for the bandwidth monitoring commands. For example, `BRS [i 5]` is the prompt for interface 5.

If you do not want to use BRS circuit classes, leave all circuits in the default c-class and do not create any other circuit classes.

Queuing Support

With bandwidth reservation over Frame Relay, each circuit can queue frames while in the congested state, even for interfaces and circuits that are not enabled for bandwidth reservation.

Discard Eligibility

The Frame Relay 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 Frame Relay network will discard frames marked as discard eligible, which may allow frames that are not marked discard eligible to make it through the network. When assigning a protocol, filter, or tag to a traffic class, you can specify whether or not the protocol, filter, or tag traffic is discard eligible. See “Assign” on page 25 for more information on how to configure traffic as discard eligible.

Default Circuit Definitions for Traffic Class Handling

Frame Relay interfaces can have many circuits defined. Rather than having to fully configure traffic class definitions for each circuit, BRS allows you to define a default set of traffic classes and protocol, filter, and tag assignments called default circuit definitions that can be used by any circuit on the interface. When BRS is initially enabled on a circuit, the circuit is initialized to use default circuit definitions. If a circuit cannot use the default circuit definitions for traffic class handling then you can create circuit specific definitions by using the **add-class**, **change-class**, **assign**, **deassign**, **tag**, and **untag** commands.

If a circuit is using circuit specific definitions and you want it to use the default circuit definitions instead, you can use the **use-circuit-defaults** command at the circuit’s BRS prompt.

The default circuit definitions for traffic class handling are defined by using the **set-circuit-defaults** at the BRS Frame Relay interface prompt. This command gets you to a BRS circuit defaults prompt where you can add, change, and delete traffic classes, assign and deassign protocols, filters, and tags, and create BRS tags. Changes to the default circuit definitions for traffic classes result in dynamic updates to the traffic class handling for all circuits using the default circuit definitions.

Priority Queuing

Bandwidth reservation allocates percentages of total connection bandwidth for specified traffic *classes*, or *t-classes*, defined by the user. A BRS t-class is a group of packets identified by the same name; for example, a class called “ipx” to designate all IPX packets.

With priority queuing, each bandwidth t-class can be assigned one of the following priority level settings:

- Urgent
- High
- Normal (the default setting)
- Low

All packets assigned the Urgent priority are sent first within their class. These packets are followed by High, Normal, and then Low messages respectively. When all Urgent packets have been transmitted, High packets are transmitted until all are sent (or until new Urgent messages are queued). Only when there are no Urgent, High, or Normal packets remaining are the Low priority packets transmitted. If no priority setting is assigned, the setting defaults to Normal.

Also, you can set the number of packets that are waiting in the queue for each priority level in each bandwidth t-class. The BRS **queue-length** command sets the maximum number of output buffers that can be queued in each BRS priority queue, and the maximum number of output buffers that can be queued in each BRS priority queue for when router input buffers are scarce. You can set up priority queue lengths for both PPP and Frame Relay.

Attention: If you set the values for queue length too high, you may seriously degrade the performance of your router.

For BRS, you can set priority queue lengths for PPP and Frame Relay WAN connections. See “Queue-length” on page 37 for a description of the **queue-length** command.

The priority settings in one bandwidth t-class have no effect on other bandwidth classes. No one bandwidth class has priority over the others.

Priority Queuing Without Bandwidth Reservation

When priority queuing is configured without bandwidth reservation, the highest priority traffic is delivered first. In instances of heavy high-priority traffic, lower priority levels can be overlooked. By combining priority queuing with bandwidth reservation, however, packet transmission can be allocated to all types of traffic.

Configuring Traffic Classes

You create a traffic class using the **add-class** command and then assign types of traffic to the class using the **assign** command. Traffic is assigned to a traffic class based on its *protocol type* or based on a filter that further identifies a specific type of *protocol traffic* (for example, SNMP IP packets).

Supported protocol types are:

- IP
- ARP
- DNA
- VINES
- IPX
- OSI
- AP2
- ASRT
- SNA/APPN-ISR
- APPN-HPR
- HPR/IP

BRS Filters

Using bandwidth reservation, you can treat specific protocol traffic differently from other traffic that is using the same protocol type. For example, you can assign SNMP IP traffic to a different traffic class and priority than other IP traffic. In this example, SNMP is a BRS filter because it ″filters″ (i.e. uniquely identifies) specific protocol traffic. IP, ASRT (bridging) and APPN-HPR protocol traffic can be ″filtered″ by bandwidth reservation and the following filters are supported:

- IP tunneling
- SDLC tunneling over IP (SDLC Relay)
- BSC tunneling over IP (BSC Relay)
- Rlogin
- Telnet
- SNA/APPN-ISR
- APPN-HPR
- SNMP
- IP Multicast
- DLSw
- MAC Filter
- NetBIOS
- Network-HPR
- High-HPR
- Medium-HPR
- Low-HPR
- XTP
- TCP/UDP port numbers or sockets
- TOS byte
- precedence bit

BRS and Filtering

The following sections describe how to use BRS with various types of filtering.

MAC Address Filtering and Tags

MAC Address filtering is handled by a joint effort between bandwidth reservation and MAC filtering (MCF) using *tags*. For example, a user with bandwidth reservation is able to categorize bridge traffic by assigning a tag to it.

The tagging process is done by creating a filter item in the MAC filtering configuration console and then assigning a tag number to it. This tag number is used to set up a traffic class for all packets associated with this tag. Tag values must currently be in the range 1 through 64. See “Chapter 3. Using MAC Filtering” on page 45 for additional information about MAC filtering.

Note: Tags can be applied ***only*** to bridged packets. On a PPP or Frame Relay connection, up to five tagged MAC filters can be assigned as bandwidth reservation filters and are designated as TAG1 through TAG5. TAG1 is searched for first, then TAG2, and so on up to TAG5. A single MAC filter tag can consist of any number of MAC Addresses set in MCF.

Once you have created a tagged filter in the MAC filtering configuration process, you can use the BRS tag configuration command to assign a BRS tag name (TAG1, TAG2, TAG3, TAG4, or TAG5) to the MAC filter tag number. Then use the BRS tag name on the BRS assign command to assign the corresponding MAC filter to a bandwidth traffic class and priority.

Tags also can refer to “groups,” as in the example of IP Tunnel. IP Tunnel endpoints can belong to any number of groups. Packets are assigned to a particular group through the tagging feature of MAC Address filtering. For additional information on MAC filtering, refer to “Chapter 3. Using MAC Filtering” on page 45 and “Chapter 4. Configuring and Monitoring MAC Filtering” on page 49.

To apply bandwidth reservation and queuing priority to tagged packets:

1. Use the MAC filtering configuration commands at the `filter config>` prompt to set up tags for packets passing through the bridge. Refer to “Chapter 3. Using MAC Filtering” on page 45 for more information.
2. Use the bandwidth reservation **tag** command to reference a tag for bandwidth reservation.
3. With the bandwidth reservation **assign** command, assign the BRS tag to a t-class. The **assign** command also prompts you for a queuing priority within that BRS t-class.

TCP/UDP Port Number Filtering

You can assign TCP/IP packets from a range of TCP or UDP ports to a BRS t-class and priority based on the packet’s UDP or TCP port number and, optionally, upon a socket. You can specify up to 5 UDP/TCP port number filters, where the filters specify either an individual TCP or UDP port number, a range of TCP or UDP port numbers, or a socket identifier (combination of port number and IP address). You can then assign that filter to a BRS traffic class and priority within the class.

If UDP/TCP port filtering is enabled, BRS looks at each TCP or UDP packet and checks to see if the destination or source port number matches one of the port numbers you have specified for filtering. Also, if you define an IP address as part of the BRS UDP/TCP filter and the destination or source IP address matches the filter address you define, BRS assigns the packet to the traffic class and priority for that port number filter.

For example, you can configure a UDP port number filter for UDP port numbers in the range 25 to 29 and assign the filter to traffic class ’A’ with a priority of ’normal’. BRS queues any UDP packets with a source or destination port number from 25 to 29 on the normal priority queue for traffic class ’A’.

You can also configure a TCP port number filter for TCP port number 50 for IP address 5.5.5.25 and assign the filter to traffic class ’B’ with priority ’urgent’. BRS queues any TCP packets whose source or destination port number is 50 and whose destination or source IP address is 5.5.5.25 on the urgent priority queue for traffic class ’B’.

IPv4 TOS Bit Filtering

You can create filters that will distinguish different types of IP traffic based upon the settings of the Type of Service (TOS) bits. These TOS filters can be used to assign IPv4 traffic that has particular settings of the TOS bits to a different class and

priority than other types of IP traffic. Each filter allows IPv4 traffic whose TOS byte value matches the definition of a configured TOS filter to be assigned a unique traffic class and priority. Configuration of a TOS filter includes a mask value specification to define which bits within the TOS byte are to be matched as well as specification of low and high range values for bits that fall within the mask. The filtering mechanism is based solely on IPv4 TOS values; therefore, it does not rely on identification of IPv4 protocol type or port number information as do most of the other IP filters.

This filter is more expansive in its application than BRS IPv4 precedence filtering, which is concerned only with the high-order 3 bits of the TOS byte. When combined with IP access control support to set TOS bits, BRS TOS bit filter support enables you to perform filtering for traffic that is sent over a secure tunnel, that is fragmented, or that cannot be identified using the BRS UDP and TCP port number filter support. Also, IP access control support allows you to set the TOS bits to a user-defined value instead of having to use the hard-coded precedence bit values for APPN and DLSw that are associated with BRS IPv4 precedence bit filtering. Therefore, it is recommended that you use IP access control and BRS TOS filter support instead of BRS IPv4 precedence bit filtering.

As indicated in “Order of Filtering Precedence” on page 10, TOS filter matches are checked prior to IPv4 precedence bit filters and other IP-specific filters. Checks for the TOS1 to TOS5 filter matches are done sequentially, beginning with the TOS1 filter. Up to 5 TOS filters can be defined.

Important: Keep in mind that a packet with a particular TOS value is handled according the first TOS filter definition that the value matches. Be careful to set up your filters so that a particular TOS byte is filtered by the intended filter, not accidentally filtered by a lower-numbered filter. Refer to “Using IP” in *Using and Configuring Features* for more information.

Using IP Version 4 Precedence Bit Processing for SNA Traffic in IP Secure Tunnels and Secondary Fragments

BRS normally differentiates IP TCP and UDP traffic according to its port numbers. However, BRS cannot identify the ports after traffic has been encapsulated twice, such as IP traffic transported through an IP secure tunnel or in a secondary UDP or TCP fragment. IP version 4 precedence bit processing has been added to BRS to enable BRS to filter IP secure tunnel packets or TCP and UDP secondary fragment packets.

Note: It is recommended that you use BRS IPv4 TOS bit filtering instead of IPv4 precedence bit processing. See “IPv4 TOS Bit Filtering” on page 7 for more details.

When APPN/HPR traffic is being routed over IP, each transmission priority of APPN-HPR (network, high, medium, and low) is mapped to a particular value of the three IP version 4 precedence bits.

- The HPR network transmission priority maps to the IPv4 precedence value of '110'b.
- The HPR high transmission priority maps to the IPv4 precedence value of '100'b.
- The HPR medium transmission priority maps to the IPv4 precedence value of '010'b.

- The HPR low transmission priority maps to the IPv4 precedence value of '001'b.

When IPv4 precedence filtering is enabled for BRS and the precedence bits in an IP packet match one of the values used for APPN/HPR traffic, then the packet is queued on the priority queue of the BRS t-class to which the corresponding HPR transmission priority is assigned. For example, if an IP packet has a precedence value of '110'b and the BRS HPR-Network filter is assigned to t-class A and priority level normal, then the packet is queued on the normal priority queue of t-class A. If a BRS HPR transmission priority filter is not configured, but the APPN-HPR filter is configured, then the packet is queued on the priority queue and t-class to which the APPN-HPR filter is assigned.

These three kinds of traffic map to the IPv4 precedence value '011'b:

- APPN/HPR XID traffic that is sent when APPN/HPR is routed over IP
- DLSw traffic
- TN3270 traffic

Because several types of traffic map to one value, BRS cannot distinguish between them when it is enabled to filter based on the IPv4 precedence bits. Therefore, when BRS encounters an IP packet with a precedence value of '011'b, it evaluates the BRS filters in the following order to determine whether or not the filter is enabled. When it finds a BRS filter that is configured, the packet is queued on the priority queue and t-class to which the BRS filter is assigned:

- SNA/APPN-ISR (used for APPN/HPR XID exchanges)
- DLSw
- Telnet

If a packet has one of the precedence values that are filtered by BRS, but none of the applicable BRS filter types are configured, the packet is queued on the priority queue and the BRS t-class to which the IP protocol is assigned.

When TN3270 traffic is sent by a client to the 2212 over a wide-area network where BRS is enabled, traffic from the client cannot be prioritized by BRS unless the client sets the precedence bits to '011'b.

You must configure IPv4 precedence bit handling in multiple places:

1. In BRS you configure whether or not BRS should filter based on the IPv4 precedence bits. It only performs this type of filtering for IP secure tunnel packets or TCP and UDP secondary fragment packets.
2. When you configure DLSw, HPR over IP, and TN3270, you specify whether or not the 2212 should set the IPv4 precedence bits for packets that it originates for each of these protocol types.

Perform these three steps to use IPv4 precedence bit filtering:

1. Activate IPv4 precedence filtering in BRS.
2. Configure BRS t-classes and assign protocols and filters for various categories of SNA traffic, as you would for SNA traffic that is not transported in an IP secure tunnel or is not fragmented.
3. Enable the setting of the IPv4 precedence bits when configuring the DLSw, HPR over IP, and TN3270 protocols.
4. Configure IPsec to create a secure tunnel over which the DLSw, HPR over IP, and TN3270 traffic will flow.

SNA and APPN Filtering for Bridged Traffic

The SNA/APPN-ISR filter allows you to assign SNA and APPN-ISR traffic that is being bridged to a BRS traffic class. SNA and APPN-ISR traffic is identified as any bridged packets with a destination or source SAP of 0x04, 0x08, or 0x0C and whose LLC (802.2) control field indicates that it is not an unnumbered information (UI) frame.

Note: Frame Relay BAN packets are in this category.

The APPN-HPR filters allow you to assign HPR traffic that is being bridged to a BRS t-class. HPR traffic is identified as any bridge packet with a destination or source SAP of X'04', X'08', X'0C', or X'C8' and whose LLC (802.2) control field indicates it is an unnumbered information (UI) frame.

The Network-HPR, High-HPR, Medium-HPR, and Low-HPR filters allow HPR bridge traffic to further be filtered according to the HPR transmission priority. For example, if you want to assign HPR traffic that uses the network transmission priority to one t-class and priority and all other HPR bridged traffic to a different t-class or priority, you would assign the Network-HPR filter to the appropriate t-class and priority and use the APPN-HPR filter to assign the rest of the HPR traffic to a different t-class or priority.

APPN-HPR traffic that is being routed over IP is filtered using the UDP port number assigned for network, high, medium and low HPR transmission priorities. An additional UDP port number is used for XID exchanges. All of the UDP port numbers used to support APPN-HPR over IP are configurable.

If APPN is not enabled in an intermediate router in the IP network, you can configure UDP port numbers for HPR over IP from the `BRS Config>` command prompt. If APPN is enabled in the device, BRS will use the values configured at the `APPN Config>` command prompt.

Other filters may help you to assign traffic. For example, the DLSw filter allows you to assign SNA-DLSw traffic that is being sent over a TCP connection to a BRS t-class.

For SNA/APPN-ISR and APPN-HPR filters, if you want to check for SAPs other than the ones above, create a sliding window filter using MAC filtering and tag that filter. Then assign the tagged MAC filter to a BRS t-class.

Order of Filtering Precedence

It is possible for a packet to match more than one BRS filter type. For example, an IP tunneled bridge packet containing SNA data could match the IP tunneling filter and the SNA/APPN-ISR filter. The order in which the filters are evaluated to determine whether or not a packet matches a BRS filter type is as follows:

1. TOS filters (IP)
2. IPv4 precedence handling
3. MAC filter tag match for bridging packets (IP/ASRT)
4. NetBIOS for bridging (IP/ASRT)
5. SNA/APPN-ISR for bridging (IP/ASRT)
6. HPR-Network (IP/ASRT/APPN-HPR)
7. HPR-High (IP/ASRT/APPN-HPR)

8. HPR-Medium (IP/ASRT/APPN-HPR)
9. HPR-Low (IP/ASRT/APPN-HPR)
10. APPN-HPR (IP/ASRT)
11. UDP/TCP port number filters (IP)
12. IP tunneling (IP)
13. SDLC/BSC relay (IP)
14. DLSw (IP)
15. Multicast (IP)
16. SNMP (IP)
17. Rlogin (IP)
18. Telnet (IP)
19. XTP (IP)

Note: The protocols for which a filter applies are shown in parentheses.

Sample Configurations

Using Default Circuit Definitions for Traffic Class Handling of Frame Relay Circuits

Notes:

1 Configure feature BRS.

2 Enable BRS on interface 1.

3 Enable BRS on circuits 16, 17, 18. Default circuit definitions for traffic class handling are used for these circuits.

4 Access the set-circuit-defaults menu to define default circuit definitions for traffic class handling.

5 Add traffic classes and assign protocols and filters to the traffic classes.

6 List and show the BRS definitions for circuit 16. Since circuit 16 is using default circuit definitions, the traffic classes and protocol and filter assignments defined by the default circuit definitions are displayed.

7 Change circuit 17 from using default circuit definitions to use circuit-specific definitions for traffic class handling by creating a unique class, CIRC171. This class can have protocols, filters, or tags assigned to it.

8 Change the default circuit definitions such that the DEF1 and DEF2 traffic classes each reserve 10% of the bandwidth and then show that these changes are picked up by circuit 16 but not by circuit 17, since circuit 17 is now using circuit-specific definitions.

9 Alter circuit 17 to use default circuit definitions for traffic class handling instead of circuit-specific definitions.

```
t 6
 Gateway user configuration
 Config>feature brs     1
 Bandwidth Reservation User Configuration
 BRS Config>interface 1    2
 BRS [i 1]Config>enable
 Please reload router for this command to take effect.
 BRS [i 1] Config>circuit 16   3
 BRS [i 1][dlci 16] Config>enable
 Defaults are in effect for this circuit.
```

```
Please reload router for this command to take effect.
BRS [i 1][dlci 16] Config>exit
BRS [i 1]Config>circuit 17
BRS [i 1][dlci 17] Config>enable
Defaults are in effect for this circuit.
Please reload router for this command to take effect.
BRS [i 1][dlci 17] Config>exit
BRS [i 1]Config>circuit 18
BRS [i 1][dlci 18] Config>enable
Defaults are in effect for this circuit.
Please reload router for this command to take effect.
BRS [i 1][dlci 18] Config>
*reload
Are you sure you want to reload the gateway? (Yes or [No]): yes



*t 6
Gateway user configuration
Config>feature brs
Bandwidth Reservation User Configuration
BRS Config>interface 1
BRS[i 1] Config>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 1
maximum queue length 10, minimum queue length 3
total bandwidth allocated 10%
total circuit classes defined (counting one default) 1


class DEFAULT has 10% bandwidth allocated
  the following circuits are assigned:
      16  using defaults.
      17  using defaults.
      18  using defaults.

default class is DEFAULT


BRS [i 1] Config>?
 ENABLE
 DISABLE
 SET-CIRCUIT-DEFAULTS
 CIRCUIT
 ADD-CIRCUIT-CLASS
 DEL-CIRCUIT-CLASS
 CHANGE-CIRCUIT-CLASS
 DEFAULT-CIRCUIT-CLASS
 ASSIGN-CIRCUIT
 DEASSIGN-CIRCUIT
 QUEUE-LENGTH
 LIST
 SHOW
 CLEAR-BLOCK
 EXIT
 BRS [i 1] Config>set-circuit-defaults    4
 BRS [i 1] [circuit defaults] Config>?
 ADD-CLASS
 DEL-CLASS
 CHANGE-CLASS
 DEFAULT-CLASS
 TAG
 UNTAG
 ASSIGN
 DEASSIGN
 LIST
 EXIT
 BRS [i 1] [circuit defaults] Config>add   5
 Class name [DEFAULT]?DEF1
 Percent bandwidth to reserve [10]? 5
 BRS [i 1] [circuit defaults] Config>add
 Class name [DEFAULT]?DEF2
 Percent bandwidth to reserve [10]?5
 BRS [i 1] [circuit defaults] Config>assign ip
 Class name [DEFAULT]?DEF1
 Priority <URGENT/HIGH/NORMAL/LOW> [NORMAL]?
 Frame Relay Discard Eligible <NO/YES> [NO]?
```

```
BRS [i 1] [circuit defaults] Config>assign asrt
Class name [DEFAULT]? DEF2
Priority <URGENT/HIGH/NORMAL/LOW> [NORMAL]?
Frame Relay Discard Eligible <NO/YES> [NO]?
BRS[i 1] [circuit defaults] Config>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 1, default circuit
total bandwidth allocated 60%
total classes defined (counting one local and one default) 4


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.



class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ARP with default priority is not discard eligible
    protocol DNA with default priority is not discard eligible
    protocol VINES with default priority is not discard eligible
    protocol IPX with default priority is not discard eligible
    protocol OSI with default priority is not discard eligible
    protocol AP2 with default priority is not discard eligible

class DEF1 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol IP with priority NORMAL is not discard eligible


class DEF2 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ASRT with priority NORMAL is not discard eligible

assigned tags:

default class is DEFAULT with priority NORMAL

BRS  [i 1] [circuit defaults] Config>exit
BRS  [i 1] Config>circuit 16    6
BRS  [i 1][dlci 161] Config>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 1, circuit number 16 using defaults.
maximum queue length 10, minimum queue length 3
total bandwidth allocated 60%
total classes defined (counting one local and one default) 4


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.


class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ARP with default priority is not discard eligible
    protocol DNA with default priority is not discard eligible
    protocol VINES with default priority is not discard eligible
    protocol IPX with default priority is not discard eligible
    protocol OSI with default priority is not discard eligible
    protocol AP2 with default priority is not discard eligible

class DEF1 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol IP with priority NORMAL is not discard eligible


class DEF2 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ASRT with priority NORMAL is not discard eligible

assigned tags:

default class is DEFAULT with priority NORMAL
```

```
BRS  [i 1] [dlci 16] Config>show

 BANDWIDTH RESERVATION currently in RAM
 interface number 1, circuit number 16 using defaults.
 maximum queue length 10, minimum queue length 3
 4 current defined classes:
   class LOCAL has 10% bandwidth allocated
   class DEFAULT has 40% bandwidth allocated
   class DEF1 has 5% bandwidth allocated
   class DEF2 has 5% bandwidth allocated

 protocol and filter assignments:

 Protocol/Filter      Class              Priority    Discard Eligible
 ---------------      -----              --------    ----------------
 IP                   DEF1                 NORMAL            NO
 ARP                  DEFAULT              NORMAL            NO
 DNA                  DEFAULT              NORMAL            NO
 VINES                DEFAULT              NORMAL            NO
 IPX                  DEFAULT              NORMAL            NO
 OSI                  DEFAULT              NORMAL            NO
 AP2                  DEFAULT              NORMAL            NO
 ASRT                 DEF2                 NORMAL            NO

 BRS [i 1] [dlci 16] Config>exit


BRS [i 1] Config>circuit 17
 BRS [i 1] [dlci 17] Config>list

 BANDWIDTH RESERVATION listing from SRAM
 bandwidth reservation is enabled
 interface number 1, circuit number 17 using defaults.
 maximum queue length 10, minimum queue length 3
 total bandwidth allocated 60%
 total classes defined (counting one local and one default) 4


 class LOCAL has 10% bandwidth allocated
   protocols and filters cannot be assigned to this class.


 class DEFAULT has 40% bandwidth allocated
   the following protocols and filters are assigned:
     protocol ARP with default priority is not discard eligible
     protocol DNA with default priority is not discard eligible
     protocol VINES with default priority is not discard eligible
     protocol IPX with default priority is not discard eligible
     protocol OSI with default priority is not discard eligible
     protocol AP2 with default priority is not discard eligible

 class DEF1 has 5% bandwidth allocated
   the following protocols and filters are assigned:
     protocol IP with priority NORMAL is not discard eligible


 class DEF2 has 5% bandwidth allocated
   the following protocols and filters are assigned:
     protocol ASRT with priority NORMAL is not discard eligible

 assigned tags:

 default class is DEFAULT with priority NORMAL

 BRS [i 1] [dlci 17] Config>add-class   /
 This circuit is currently using circuit defaults...
 Are you sure you want to override the defaults ?(Yes or [No]): yes
 Class name [DEFAULT]? CIRC171
 Percent bandwidth to reserve [10]? 5
 BRS[i 1] [dlci 17] Config>assign vines
 Class name [DEFAULT]? CIRC171
 Priority <URGENT/HIGH/NORMAL/LOW> [NORMAL]?
 Frame Relay Discard Eligible <NO/YES>[NO]?


BRS [i 1] [dlci 17] Config>list

 BANDWIDTH RESERVATION listing from SRAM
 bandwidth reservation is enabled
 interface number 1, circuit number 17
 maximum queue length 10, minimum queue length 3
```

```
total bandwidth allocated 65%
total classes defined (counting one local and one default) 5


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.


class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ARP with default priority is not discard eligible
    protocol DNA with default priority is not discard eligible
    protocol IPX with default priority is not discard eligible
    protocol OSI with default priority is not discard eligible
    protocol AP2 with default priority is not discard eligible


class DEF1 has 5% bandwidth allocated
  the following protocols and filters assigned:
    protocol IP with priority NORMAL is not discard eligible


class DEF2 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ASRT with priority NORMAL is not discard eligible


class CIRC171 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol VINES with priority NORMAL is not discard eligible

assigned tags:

default class is DEFAULT with priority NORMAL

BRS [i 1] [dlci 17] Config>show

BANDWIDTH RESERVATION currently in RAM
interface number 1, circuit number 17
maximum queue length 10, minimum queue length 3
5 current defined classes:
  class LOCAL has 10% bandwidth allocated
  class DEFAULT has 40% bandwidth allocated
  class DEF1 has 5% bandwidth allocated
  class DEF2 has 5% bandwidth allocated
  class CIRC171 has 5% bandwidth allocated


protocol and filter assignments:

Protocol/Filter      Class              Priority    Discard Eligible
---------------      -----              --------    ----------------
IP                   DEF1                 NORMAL             NO
ARP                  DEFAULT              NORMAL             NO
DNA                  DEFAULT              NORMAL             NO
VINES                CIRC171              NORMAL             NO
IPX                  DEFAULT              NORMAL             NO
OSI                  DEFAULT              NORMAL             NO
AP2                  DEFAULT              NORMAL             NO
ASRT                 DEF2                 NORMAL             NO

BRS [i 1] [dlci 17] Config>exit
BRS [i 1] Config>set-circuit-defaults
BRS [i 1] [circuit defaults] Config>change DEF1    8
Percent bandwidth to reserve [ 5]? 10
BRS [i 1] [circuit defaults] Config>change DEF2
Percent bandwidth to reserve [5]? 10
BRS [i 1] [circuit defaults] Config>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 1, default circuit
total bandwidth allocated 70%
total classes defined (counting one local and one default) 4


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.
```

```
  class DEFAULT has 40% bandwidth allocated
    the following protocols and filters are assigned:
      protocol ARP with default priority is not discard eligible
      protocol DNA with default priority is not discard eligible
      protocol VINES with default priority is not discard eligible
      protocol IPX with default priority is not discard eligible
      protocol OSI with default priority is not discard eligible
      protocol AP2 with default priority is not discard eligible

  class DEF1 has 10% bandwidth allocated
    the following protocols and filters are assigned:
      protocol IP with priority NORMAL is not discard eligible


  class DEF2 has 10% bandwidth allocated
    the following protocols and filters are assigned:
      protocol ASRT with priority NORMAL is not discard eligible

  assigned tags:

  default class is DEFAULT with priority NORMAL

  BRS [i 1] [circuit defaults] Config>exit


BRS [i 1] Config>circuit 16
  BRS [i 1] [dlci 16] Config>list

  BANDWIDTH RESERVATION listing from SRAM
  bandwidth reservation is enabled
  interface number 1, circuit number 16 using defaults.
  maximum queue length 10, minimum queue length 3
  total bandwidth allocated 70%
  total classes defined (counting one local and one default) 4


  class LOCAL has 10% bandwidth allocated
    protocols and filters cannot be assigned to this class.


  class DEFAULT has 40% bandwidth allocated
    the following protocols and filters are assigned:
      protocol ARP with default priority is not discard eligible
      protocol DNA with default priority is not discard eligible
      protocol VINES with default priority is not discard eligible
      protocol IPX with default priority is not discard eligible
      protocol OSI with default priority is not discard eligible
      protocol AP2 with default priority is not discard eligible

  class DEF1 has 10% bandwidth allocated
    the following protocols and filters are assigned:
      protocol IP with priority NORMAL is not discard eligible


  class DEF2 has 10% bandwidth allocated
    the following protocols and filters are assigned:
      protocol ASRT with priority NORMAL is not discard eligible

  assigned tags:

  default class is DEFAULT with priority NORMAL

  BRS [i 1] [dlci 16] Config>exit


BRS [i 1] Config>circuit 17
  BRS [i 1[ [dlci 17] Config>list

  BANDWIDTH RESERVATION listing from SRAM
  bandwidth reservation is enabled
  interface number 1, circuit number 17
  maximum queue length 10, minimum queue length 3
  total bandwidth allocated 65%
  total classes defined (counting one local and one default) 5


  class LOCAL has 10% bandwidth allocated
    protocols and filters cannot be assigned to this class.
```

```
class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ARP with default priority is not discard eligible
    protocol DNA with default priority is not discard eligible
    protocol IPX with default priority is not discard eligible
    protocol OSI with default priority is not discard eligible
    protocol AP2 with default priority is not discard eligible


class DEF1 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol IP with priority NORMAL is not discard eligible


class DEF2 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ASRT with priority NORMAL is not discard eligible


class CIRC171 has 5% bandwidth allocated
  the following protocols and filters are assigned:
    protocol VINES with priority NORMAL is not discard eligible

assigned tags:

default class is DEFAULT with priority NORMAL

BRS [i 1] [dlci 17] Config>use-circuit-defaults
This circuit is currently NOT using circuit defaults...
Are you sure you want to delete current definitions and use defaults ? (Yes or
[No]): yes
Defaults are in effect for this circuit.
Please reload router for this command to take effect.
BRS [i 1] [dlci 17] Config>
*restart
Are you sure you want to reload the gateway? (Yes or [No] ):yes


*t 6
Gateway user configuration
Config>feature brs
Bandwidth Reservation User Configuration
BRS Config>interface 1
BRS [i 1] Config>circuit 17
BRS [i 1] [dlci 17] Config>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 1, circuit number 17 using defaults.
maximum queue length 10, minimum queue length 3
total bandwidth allocated 70%
total classes defined (counting one local and one default) 4


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.


 class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ARP with default priority is not discard eligible
    protocol DNA with default priority is not discard eligible
    protocol VINES with default priority is not discard eligible
    protocol IPX with default priority is not discard eligible
    protocol OSI with default priority is not discard eligible
    protocol AP2 with default priority is not discard eligible

class DEF1 has 10% bandwidth allocated
  the following protocols and filters are assigned:
    protocol IP with priority NORMAL is not discard eligible


class DEF2 has 10% bandwidth allocated
  the following protocols and filters are assigned:
    protocol ASRT with priority NORMAL is not discard eligible

assigned tags:
```

```
default class is DEFAULT with priority NORMAL


BRS [i 1] [dlci 17] Config>show

BANDWIDTH RESERVATION currently in RAM
interface number 1, circuit number 17 using defaults.
maximum queue length 10, minimum queue length 3
4 current defined classes:
  class LOCAL has 10% bandwidth allocated
  class DEFAULT has 40% bandwidth allocated
  class DEF1 has 10% bandwidth allocated
  class DEF2 has 10% bandwidth allocated

protocol and filter assignments:

Protocol/Filter      Class              Priority    Discard Eligible
---------------      -----              --------    ----------------
IP                   DEF1                 NORMAL             NO
ARP                  DEFAULT              NORMAL             NO
DNA                  DEFAULT              NORMAL             NO
VINES                DEFAULT              NORMAL             NO
IPX                  DEFAULT              NORMAL             NO
OSI                  DEFAULT              NORMAL             NO
AP2                  DEFAULT              NORMAL             NO
ASRT                 DEF2                 NORMAL             NO

BRS [i 1] [dlci 17] Config>exit
```

Chapter 2. Configuring and Monitoring Bandwidth Reservation

This chapter describes the Bandwidth Reservation System (BRS) configuration and operational commands.

This chapter includes the following sections:

Bandwidth Reservation Configuration Overview

To access bandwidth reservation configuration commands and configure bandwidth reservation on your router:

1. At the `OPCON (*)` prompt, enter **talk 6**.
2. At the `Config>` prompt, enter **feature brs**.
3. At the `BRS Config>` prompt, enter **interface #**.
4. At the `BRS [i 0] Config>` prompt, enter **enable**.

   This is the interface prompt level, and the interface number is zero in this instance. You need to repeat step 3 and step 4 for each interface you are configuring.

   If you are configuring BRS on a Frame Relay interface, continue with step 4a:

   If you are configuring BRS on any other interface, go directly to step 5.

   a. At the `BRS [i 0] Config>` prompt, enter **circuit** *#*, where *#* is the number of the circuit you want to configure.

   b. At the `BRS [i 0] [dlci 16] Config>` prompt, enter **enable**. This is the circuit prompt level and the circuit (DLCI) number is 16 in this instance.

   c. At the `BRS [i 0] [dlci 16] Config>` prompt, enter **exit** to return to the interface level prompt.

   d. Repeat steps 4a through 4c for each circuit for which you want to define BRS t-classes.
5. Reload your router.
6. Repeat steps 1 through 3 to configure bandwidth reservation for the particular interface that you have enabled.
7. If you are configuring BRS on a PPP interface, at the `BRS[i 0]Config>` prompt, configure traffic classes and assign protocols, filters, and tags to the traffic classes using the configuration commands listed in Table 3 on page 22. If you are configuring BRS on a FR interface, follow steps 8 through 10.
8. If you are configuring BRS on a FR interface, you can configure circuit classes and assign circuits to circuit classes using the commands listed in Table 2 on page 21
9. If you want to use default circuit definitions then enter the **set-circuit-defaults** command at the `BRS[i 0]Config>` prompt. This gets you to the `BRS[i 0][circuit defaults]` prompt where you can use the appropriate commands from Table 3 on page 22 to configure traffic classes and assign protocols, filters,

and tags to the traffic classes. Once you are through defining default circuit definitions for traffic class handling, enter ″exit″ to return to the `BRS[i 0] Config>` prompt.

10. If you have FR circuits that cannot use default circuit definitions for traffic class handling, enter **circuit** *permanent-virtual-circuit circuit_number*. This will access the circuit prompt where you can use the commands listed in Table 3 on page 22 to create circuit-specific definitions for traffic class handling.

Note: You do not need to reload the router for t-class and c-class configuration changes to take effect.

The **talk 6 (t 6)** command lets you access the configuration process.

The **feature brs** command lets you access the BRS configuration process. You can enter this command by using either the feature name (brs) or number (1).

The **interface #** command selects the particular interface that you want to configure for bandwidth reservation. Before configuring any BRS classes, you must use the **enable** command to enable BRS on the interface. In Step 4 on page 19, the prompt indicates that the selected interface's number is zero.

The **circuit #** command selects the circuit on the FR interface on which you want to configure BRS traffic classes. Before configuring any BRS t-classes for the circuit, you must use the **enable** command to enable BRS on the circuit. In step 4.b on page 19 , the prompt indicates that circuit 16 on interface 0 has been selected.

You must enable bandwidth reservation for the selected interface and circuit and then reload your router before configuring circuit classes (Frame Relay only), and traffic classes.

To return to the `Config>` prompt at any time, enter the **exit** command at the different levels of BRS prompts until you are at the `Config>` prompt.

Bandwidth Reservation Configuration Commands

This section describes the Bandwidth Reservation configuration commands. The commands that can be used differ depending on the BRS configuration prompt that is displayed (`BRS Config>`, `BRS [i x] Config>`, or `BRS [i x] [dlci y] Config>`, or `BRS [i x] [circuit defaults] Config>`).

Table 1. Bandwidth Reservation Configuration Command Summary (Available from BRS Config> prompt)

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 xxvi.
Activate-IP-precedence-filtering	Activate BRS IPv4 precedence filtering of APPN and SNA packets that are sent over a secure IP tunnel or that are in secondary TCP or UDP fragments. You also must configure the setting of the IPv4 precedence bits when you configure DLSw, HPR over IP or TN3270.

Table 1. Bandwidth Reservation Configuration Command Summary (Available from BRS Config> prompt) (continued)

Command	Function
Deactivate-IP-precedence-filtering	Deactivates IPv4 precedence filtering processing.
Enable-hpr-over-ip-port-numbers	Enables the use of BRS filtering for APPN-HPR over IP traffic and allows the configuration of the UDP port numbers used to identify HPR over IP packets. **Note:** If APPN is in the load image, this command is not supported since BRS learns from APPN if HPR over IP has been configured and, if it has been configured, learns the UDP port numbers that will be used for HPR over IP packets from the APPN support.
Disable-hpr-over-ip-port-numbers	Disables BRS filtering of APPN-HPR over IP traffic. **Note:** If APPN is in the load image, this command is not supported since BRS learns from APPN whether or not HPR over IP has been configured.
Interface	Selects an interface on which to configure bandwidth reservation. **Note:** This command must be entered before using any other configuration commands. See Table 2 and Table 3 on page 22 .
List	Lists the interfaces that can support bandwidth reservation and, for each interface, indicates if bandwidth reservation is enabled or disabled.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Table 2. BRS Interface Configuration Commands Available from BRS [i #] Config> prompt for Frame Relay Interfaces

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 xxvi.
Add-circuit-class	Sets the name of a bandwidth c-class and its percentage of bandwidth.
Assign-circuit	Assigns a specified circuit to the specified bandwidth c-class.
Change-circuit-class	Changes the amount of bandwidth configured for a bandwidth c-class.
Circuit	Accesses the BRS circuit-level prompt (`BRS [i x][dlci y] Config>`) prompt where you can use the commands listed in Table 3 on page 22 to configure Bandwidth Reservation on the Frame Relay circuit.
Clear-block	Clears the configuration data associated with the current interface from SRAM. Circuit class configuration data and default circuit definitions for traffic class handling are cleared.
Deassign-circuit	Restores the specified circuit to the default c-class
Default-circuit-class	Assigns the name of a default bandwidth c-class and its percentage of the interface’s bandwidth.
Del-circuit-class	Deletes the specified bandwidth c-class.

Table 2. BRS Interface Configuration Commands Available from BRS [i #] Config> prompt for Frame Relay Interfaces (continued)

Command	Function
Disable	Disables bandwidth reservation on the interface .
Enable	Enables bandwidth reservation on the interface.
List	Displays the c-classes and assigned circuit definitions from SRAM.
Queue-length	Sets the maximum and minimum values for the number of packets in a priority queue.
Set-circuit-defaults	Accesses the `BRS [i x] [circuit defaults] Config>` command prompt so that you can use the appropriate commands from Table 3 to create default circuit definitions for traffic class handling.
Show	Displays the currently defined c-classes and assigned circuits from SRAM.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

The following table lists BRS circuit commands Available from `BRS [i x] Config>` for PPP interfaces, `BRS [i x] dlci [y] Config>` prompt for Frame Relay circuits, and from the `BRS [i x] [circuit defaults] Config>` prompt.

Table 3. BRS Traffic Class Handling 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 xxvi.
Add-class	Allocates a designated amount of bandwidth to a user-defined traffic class.
Assign	Assigns a protocol or filter to a configured traffic class.
Change-class	Changes the amount of bandwidth configured for a bandwidth t-class.
Clear-block	Clears the traffic class and protocol, filter, and tag assignment configuration data from SRAM for the PPP interface or Frame Relay circuit. **Note:** This command cannot be used from the `BRS [i x] [circuit defaults] Config>` prompt.
Deassign	Restores the queuing of the specified packet or filter to the default t-class and priority.
Default-class	Sets the default t-class and priority to a desired value and assigns all unassigned protocols to the new default t-class.
Del-class	Deletes a previously configured bandwidth t-class.
Disable	Disables bandwidth reservation on the PPP interface or Frame Relay circuit. **Note:** BRS cannot be enabled or disabled from the `BRS [i x] [circuit defaults] Config>` prompt.
Enable	Enables bandwidth reservation on the PPP interface or Frame Relay circuit. **Note:** BRS cannot be enabled or disabled from the `BRS [i x] [circuit defaults] Config>` prompt.
List	Lists the configured t-classes and protocol, filter and tag assignments stored in SRAM.
Queue-length	Sets the maximum and minimum values for the number of packets in a priority queue. **Note:** This command is not supported at the `BRS [i x] [circuit defaults] Config>` prompt.

Table 3. BRS Traffic Class Handling Commands (continued)

Command	Function
Show	Displays the currently defined t-classes and protocol, filter, and tag assignments stored in RAM. **Note:** This command is not supported at the `BRS [i x] [circuit defaults] Config>` prompt.
Tag	Assigns a BRS tag name (TAG1 - TAG5) to a MAC filter that has been tagged during the configuration of the MAC Filtering feature.
Untag	Removes the relationship between a BRS tag name (TAG1 - TAG5) and a MAC filter that has been tagged during configuration of the MAC filtering feature.
Use-circuit-defaults	Allows the user to delete the circuit-specific definitions and use the circuit-defaults definitions for the traffic-class handling. This command is valid at the `BRS [i x] dlci [y] Config>` prompt for Frame Relay only. **Note:** The router must be reloaded in order for the defaults to become operational.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Use the appropriate commands to configure bandwidth reservation for the Point-to-Point protocol (PPP) and Frame Relay. For Frame Relay, you need to configure the circuit and the network interface. For PPP, you only need to configure the network interface.

Notes:

1. When the **clear-block, disable**, **enable**, **list**, and **show** commands are issued from within the BRS interface menu, they affect or list the bandwidth reservation information configured for the selected interface. When these commands are issued from within the BRS circuit menu, only the Frame Relay bandwidth reservation information configured for the permanent virtual circuit (PVC) is affected or listed.
2. Before using the bandwidth reservation commands, keep the following in mind:
   - You must use the **interface** command to select an interface before you use any other configuration commands. (BRS configuration enforces this.)
   - The *Class-name* parameter is case-sensitive.
   - To view the current *class-names*, use the **list** or **show** command.
   - After you enable bandwidth reservation on an interface or circuit, you can add/delete/change circuit and traffic classes and assign circuits or protocols dynamically. The only commands that require a router reload before taking effect are the enable, disable, use-circuit-defaults, and clear-block commands.
3. You do not need to reload the router for t-class and c-class configuration changes to take effect.

Activate-IP-precedence-filtering

Use the **activate-ip-precedence-filtering** command to activate BRS IPv4 precedence filtering of APPN and SNA packets that are sent over a secure IP tunnel or that are in secondary TCP or UDP fragments. You also must configure the setting of the IPv4 precedence bits when you configure DLSw, HPR over IP or TN3270. See “Using IP Version 4 Precedence Bit Processing for SNA Traffic in IP Secure Tunnels and Secondary Fragments” on page 8 for more information.

Syntax:

activate-ip-precedence-filtering

Add-circuit-class

Note: Used only when configuring Frame Relay.

Use the **add-circuit-class** command at the interface level to allocate a designated amount of bandwidth to be used by the group of circuits assigned to the user-defined bandwidth c-class.

Syntax:

add-circuit-class *class-name %*

Add-class

Use the **add-class** command to allocate a designated amount of bandwidth to a user-defined bandwidth t-class.

Note: If this command is used for a Frame Relay circuit that is currently using default circuit definitions for traffic class handling, you will be asked whether or not you want to override the default circuit definitions. If you answer “Yes”, the circuit will be changed to use circuit-specific definitions for traffic class handling and the command will be allowed. If you answer “No”, the command is aborted and default circuit definitions will continue to be used for the circuit. If you want to change the default circuit definitions, you should go to the `BRS [i x][circuit defaults]Config>` command prompt.

Syntax:

add-class [*class-name* or *class#*] *%*

Example 1: Adding one class named CIRC17 on a frame relay circuit

```
BRS [i 1] [dlci 17] Config>add-class
This circuit is currently using circuit defaults...
Are you sure you want to override the defaults ?(Yes or [No]):y
Class name [DEFAULT]? CIRC17
Percent bandwidth to reserve [10]?5
BRS [i 1] [dlci 17] Config>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 1, circuit number 17
maximum queue length 10, minimum queue length 3
total bandwidth allocated 65%
total classes defined (counting one local and one default) 5


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.


class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
    protocol DNA with default priority is not discard eligible
    protocol VINES with default priority is not discard eligible
    protocol IPX with default priority is not discard eligible
    protocol OSI with default priority is not discard eligible
    protocol AP2 with default priority is not discard eligible
    protocol ASRT with default priority is not discard eligible


class DEF1 has 5% bandwidth allocated
  protocol IP with priority NORMAL is not discard eligible.
```

```
class DEF2 has 5% bandwidth allocated
 protocol ARP with priority NORMAL is not discard eligible.


class CIRC171 has 5% bandwidth allocated
  no protocols or filters are assigned to this class.

assigned tags:

default class is DEFAULT with priority NORMAL
```

Example 2: Adding one class named class1 on a frame relay circuit

```
BRS [i 2] [dlci 128]>add
This circuit is currently using circuit defaults...
Are you sure you want to override the defaults ?(Yes or [No]): y
Class name [DEFAULT]?
Class is already allocated.
BRS [i 2] [dlci 128]>add class1
Percent bandwidth to reserve [10]?
BRS [i 2] [dlci 128]>

BRS [i 2] [dlci 128]>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 2, circuit number 128
maximum queue length 10, minimum queue length 3
total bandwidth allocated 60%
total classes defined (counting one local and one default) 3


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.


class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
    protocol IP with default priority is not discard eligible
    protocol ARP with default priority is not discard eligible
    protocol DNA with default priority is not discard eligible
    protocol VINES with default priority is not discard eligible
    protocol IPX with default priority is not discard eligible
    protocol OSI with default priority is not discard eligible
    protocol AP2 with default priority is not discard eligible
    protocol ASRT with default priority is not discard eligible

class class1 has 10% bandwidth allocated
  no protocols or filters are assigned to this class.

assigned tags:

default class is DEFAULT with priority NORMAL

BRS [i 2] [dlci 128]>
```

Assign

Use the **assign** command to assign specified tags, protocol packets, or filters to a given t-class and priority within that class. The four priority types include:

- Urgent
- High
- Normal (the default priority)
- Low.

Syntax:

assign [*protocol-class* or TAG or *filter-class*] [*class-name* or *class#*]

The **assign** command also allows you to set the Discard-eligible (DE) bit for Frame Relay frames.

Note: If this command is used for a Frame Relay circuit that is currently using default circuit definitions for traffic class handling, you will be asked whether or not you want to override the default circuit definitions. If you answer “Yes”, the circuit will be changed to use circuit-specific definitions for traffic class handling and the command will be allowed. If you answer “No”, the command is aborted and default circuit definitions will continue to be used for the circuit. If you want to change the default circuit definitions, you should go to the `BRS [i x][circuit defaults]Config>` command prompt.

Example 1:

```
assign IPX test
priority <URGENT/HIGH/NORMAL/LOW>: [NORMAL]? low
protocol IPX maps to class test with priority LOW Discard eligible <yes/no> [N]?
```

Example 2: Assigning a TOS filter to class1; class1 has previously been added to the configuration using the *add class* command.

```
BRS [i 2] [dlci 128]>assign ?
IP
ARP
DNA
VINES
IPX
OSI
AP2
ASRT
TUNNELING-IP
SDLC/BSC-IP
RLOGIN-IP
TELNET-IP
NETBIOS
SNA/APPN-ISR
SNMP-IP
MULTICAST-IP
DLSW-IP
TAG1
TAG2
TAG3
TAG4
TAG5
APPN-HPR
NETWORK-HPR
HIGH-HPR
MEDIUM-HPR
LOW-HPR
XTP-IP
UDP_TCP1
UDP_TCP2
UDP_TCP3
UDP_TCP4
UDP_TCP5
TOS1
TOS2
TOS3
TOS4
TOS5
Protocol or filter name [IP]? TOS1 1
Class name [DEFAULT]? class1 2
Priority  [NORMAL]?
Frame Relay Discard Eligible  [NO]?
TOS Mask [1-FF] [FF]?
TOS Range (Low) [0-FF] [0]? 1
TOS Range (High) [1]? 3
BRS [i 2] [dlci 128]> list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 2, circuit number 128
maximum queue length 10, minimum queue length 3
total bandwidth allocated 60%
```

```
total classes defined (counting one local and one default) 3


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.


class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
    protocol IP with default priority is not discard eligible
    protocol ARP with default priority is not discard eligible
    protocol DNA with default priority is not discard eligible
    protocol VINES with default priority is not discard eligible
    protocol IPX with default priority is not discard eligible
    protocol OSI with default priority is not discard eligible
    protocol AP2 with default priority is not discard eligible
    protocol ASRT with default priority is not discard eligible


class class1 has 10% bandwidth allocated
  the following protocols and filters are assigned:
    filter TOS1 with priority NORMAL is not discard eligible
       with TOS range x1 - x3 and TOS mask xFF

assigned tags:

default class is DEFAULT with priority NORMAL

BRS [i 2] [dlci 128]>show

BANDWIDTH RESERVATION currently in RAM
interface number 2, circuit number 128
maximum queue length 10, minimum queue length 3
3 current defined classes:
  class LOCAL has 10% bandwidth allocated
  class DEFAULT has 40% bandwidth allocated
  class class1 has 10% bandwidth allocated

protocol and filter assignments:

Protocol/Filter      Class              Priority    Discard Eligible
---------------      -----              --------    ----------------
IP                   DEFAULT              NORMAL             NO
ARP                  DEFAULT              NORMAL             NO
DNA                  DEFAULT              NORMAL             NO
VINES                DEFAULT              NORMAL             NO
IPX                  DEFAULT              NORMAL             NO
OSI                  DEFAULT              NORMAL             NO
AP2                  DEFAULT              NORMAL             NO
ASRT                 DEFAULT              NORMAL             NO
TOS1                 class1               NORMAL             NO
   with TOS range x1 - x3
    and TOS mask xFF

BRS [i 2] [dlci 128]>
```

Using the TOS filter requires you to enter three parameters: TOS mask, TOS range-low, and TOS range- high. Refer to the command “Add” in the chapter “Configuring and Monitoring IP” in the *Protocol Configuration and Monitoring Reference Volume 1* for a description of these parameters.

Assign-circuit

Note: Used only when configuring Frame Relay.

Use the **assign-circuit** command at the interface level to assign the specified circuit to the specified bandwidth c-class. Use the DLCI when assigning a PVC to a circuit class and the circuit name when assigning an SVC to a circuit class.

Note: You must use the **circuit** command to enable BRS on the virtual circuit and reload the router before you can use this command to assign the circuit to a circuit class.

Syntax:

assign-circuit *# class name*

Change-circuit-class

Note: Used only when configuring Frame Relay.

Use the **change-circuit-class** command at the interface level to change the percentage of the bandwidth to be used by the group of circuits assigned to the specified c-class.

Syntax:

change-circuit-class *class-name %*

Change-class

Use the **change-class** command to change the amount of bandwidth configured for a bandwidth t-class.

Note: If this command is used for a Frame Relay circuit that is currently using default circuit definitions for traffic class handling, you will be asked whether or not you want to override the default circuit definitions. If you answer “Yes”, the circuit will be changed to use circuit-specific definitions for traffic class handling and the command will be allowed. If you answer “No”, the command is aborted and default circuit definitions will continue to be used for the circuit. If you want to change the default circuit definitions, you should go to the `BRS [i x][circuit defaults]Config>` command prompt.

Syntax:

change-class [*class-name* or *class#*] *%*

Circuit

Note: Used only when configuring Frame Relay.

Use the **circuit** command to configure a Frame Relay permanent virtual circuit (PVC) or switched virtual circuit (SVC). This command can only be issued from the BRS interface configuration prompt (`BRS [i #] Config>`).

Syntax:

*ci***rcuit**

Before you can use the **add-class**, **assign**, **default-class**, **del-class**, **deassign**, or **change-class** commands, you must enable BRS on the circuit and reload the router.

PVC example:

```
BRS [i 1] Config> circuit
Circuit (PVC number or SVC name) to reserve bandwidth:  [16]

BRS [i 1 ] [dlci 16] Config> enable
```

SVC example:

```
BRS [i 1] Config> circuit
Circuit (PVC number or SVC name) to reserve bandwidth:  [16] svc01

BRS [i 1 ] [svc svc01] Config> enable
```

After the **enable** command is issued for the Frame-Relay circuit and the router is reloaded, the following configuration commands are available for the circuit:

add-class	deassign	enable	tag
assign	default-class	exit	untag
change-class	del-class	list	clear-block
disable	show	use-circuit-defaults	

Clear-block

Use the **clear-block** command to clear the current bandwidth reservation configuration data from SRAM.

Syntax:

clear-block

- If you enter this command from the interface prompt for PPP, all BRS configuration data is cleared for the interface.
- If you enter this command from the interface prompt for Frame Relay, BRS is no longer enabled on the interface or on any circuits of the interface, and all circuit-class configuration data and default circuit definitions for traffic class handling are cleared. However, the traffic-class configuration data for each individual circuit is not cleared and is available if you re-enable BRS on the interface.
- To clear a circuit's traffic-class configuration data, you first enter the **circuit** command from the interface-level prompt and then the **clear-block** command from the circuit-level prompt. After you have cleared the traffic-class configuration data for each circuit, enter the **clear-block** command from the interface-level prompt to clear the circuit-class configuration data. The changes do not take effect until the router is reloaded.

Example:

```
clear-block
You are about to clear BRS configuration information for this interface
Are you sure you want to do this (Yes or No): y
BRS [i 1] Config>
```

Deactivate-IP-precedence-filtering

Use the **deactivate-ip-precedence-filtering** command to deactivate IPv4 precedence filtering processing.

Syntax:

deactivate-ip-precedence-filtering

Deassign

Use the **deassign** command to restore the queuing of the specified protocol packet or filter to the default t-class and priority.

Note: If this command is used for a Frame Relay circuit that is currently using default circuit definitions for traffic class handling, you will be asked whether or not you want to override the default circuit definitions. If you answer “Yes”, the circuit will be changed to use circuit-specific definitions for traffic class handling and the command will be allowed. If you answer “No”, the command is aborted and default circuit definitions will continue to be used for the circuit. If you want to change the default circuit definitions, you should go to the `BRS [i x][circuit defaults]Config>` command prompt.

Syntax:

deassign [*prot-class* or *filter-class*]

Deassign-circuit

Note: Used only when configuring Frame Relay.

Use the **deassign-circuit** command at the interface level to restore the queuing of the specified circuit to the default c-class.

Syntax:

deassign-c *#*

Default-circuit-class

Note: Used only when configuring Frame Relay.

Use the **default-circuit-class** command at the interface level to set the user-defined name of the default bandwidth c-class and the percentage of the bandwidth allocated to that class of circuits, including orphans, that are not assigned to a bandwidth c-class.

Syntax:

default-circuit-class *class-name %*

Del-circuit-class

Note: Used only when configuring Frame Relay.

Use the **del-circuit-class** command at the interface level to delete the specified bandwidth c-class.

Syntax:

del-circuit-class *class-name*

Default-class

Use the **default-class** command to set the default t-class and priority to a desired value. If no value has been previously assigned, system default values are used. Otherwise, the last previously assigned value is used.

Note: If this command is used for a Frame Relay circuit that is currently using default circuit definitions for traffic class handling, you will be asked whether or not you want to override the default circuit definitions. If you answer "Yes", the circuit will be changed to use circuit-specific definitions for traffic class handling and the command will be allowed. If you answer "No", the command is aborted and default circuit definitions will continue to be used for the circuit. If you want to change the default circuit definitions, you should go to the `BRS [i x][circuit defaults]Config>` command prompt.

Syntax:

default-cl [*class-name* or *class#*] *priority*

Del-class

Use the **del-class** command to delete a previously configured bandwidth t-class from the specified interface or circuit.

Note: If this command is used for a Frame Relay circuit that is currently using default circuit definitions for traffic class handling, you will be asked whether or not you want to override the default circuit definitions. If you answer "Yes", the circuit will be changed to use circuit-specific definitions for traffic class handling and the command will be allowed. If you answer "No", the command is aborted and default circuit definitions will continue to be used for the circuit. If you want to change the default circuit definitions, you should go to the `BRS [i x][circuit defaults]Config>` command prompt.

Syntax:

del-class [*class-name* or *class#*]

Disable

Use the **disable** command to disable bandwidth reservation on the interface (if entered from the interface prompt) or on the circuit (if entered from the circuit prompt). The changes do not take effect until the router is reloaded.

To verify that bandwidth reservation is disabled, enter the **list** command.

Syntax:

disable

Disable-hpr-over-ip-port-numbers

Use the **disable-hpr-over-ip-port-numbers** command to disable BRS filtering of HPR over IP traffic.

Syntax:

disable-hpr-over-ip-port-numbers

To verify that BRS filtering of HPR over IP traffic is disabled, enter the **list** command.

Note: If APPN is included in the load image, you configure whether or not HPR over IP traffic will be used at the `APPN Config>` command prompt.

Enable

Use the **enable** command to enable bandwidth reservation on the interface (if entered from the interface prompt) or the circuit (if entered from the circuit prompt). The changes do not take effect until the router is reloaded.

Syntax:

enable

Note:

- When configuring BRS on a PPP interface, issue the **enable** command at the interface prompt, and then reload the router before configuring any traffic classes and assigning protocols and filters to traffic classes.
- When BRS is initially enabled on a Frame Relay circuit, the circuit is initialized to use default circuit definitions for traffic class handling. Issue the **enable** command at the interface prompt and at the circuit prompt of each circuit for which you want to define traffic classes. Then reload the router before configuring circuit classes for the interface and traffic classes for each circuit. For example:

```
t 6
Gateway user configuration
Config>f brs
Bandwidth Reservation User Configuration
BRS Config>interface 1
BRS [i 1] Config>enable
Please reload  router for this command to take effect
BRS [i 1] Config>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
interface number 1
maximum queue length 10, minimum queue length 3
total bandwidth allocated 10%
total circuit classes defined (counting one default) 1


class DEFAULT has 10% bandwidth allocated
  no circuits are assigned to this class.

default class is DEFAULT

BRS [i 1] Config>circ 16
BRS [i 1] [dlci 16] Config>enable
Defaults are in effect for this circuit.
Please reload  router for this command to take effect.
BRS [i 1] [dlci 16] Config>ex
Please reload  router for this command to take effect.
BRS [i 1] [dlci 16] Config>
```

Enable-hpr-over-ip-port-numbers

Use the **enable-hpr-over-ip-port-numbers** command to enable BRS filtering of APPN-HPR over IP traffic and to configure UDP port numbers used to identify HPR over IP packets.

Note: If APPN is included in the load image, you enable HPR over IP and specify the UDP port numbers used for HPR over IP traffic at the `APPN Config>` command prompt.

Syntax:

enable-hpr-over-ip-port-numbers

Example:

```
BRS Config> enable-hpr-over-ip-port-numbers
XID exchange port number [12000]?
HPR net  trans prio port number [12001]?
HPR high trans prio port number [12002]?
HPR medium trans prio port number [12003]?
HPR low    trans prio port number [12004]?
```

XID exchange port number

This parameter specifies the UDP port number to be used for XID exchange. This port number must be the same as the one defined on other devices in the network.

Valid Values: 1024 - 65535

Default Value: 12000

Network priority port number

This parameter specifies the UDP port number to be used for network priority traffic. This port number must be the same as the one defined on other devices in the network.

Valid Values: 1024 - 65535

Default Value:12001

High exchange port number

This parameter specifies the UDP port number to be used for high priority traffic. This port number must be the same as the one defined on other devices in the network.

Valid Values: 1024 - 65535

Default Value:12002

Medium exchange port number

This parameter specifies the UDP port number to be used for medium priority traffic. This port number must be the same as the one defined on other devices in the network.

Valid Values: 1024 - 65535

Default Value:12003

Low exchange port number

This parameter specifies the UDP port number to be used for low priority traffic. This port number must be the same as the one defined on other devices in the network.

Valid Values: 1024 - 65535

Default Value:12004

Interface

Use the **interface** command to select the serial interface to which bandwidth reservation configuration commands will be applied. *Bandwidth reservation is supported on routers running PPP (Point-to-Point Protocol) and Frame Relay interfaces.*

Syntax:

interface *interface#*

Notes:

1. To enter bandwidth reservation commands for a new interface, this command must be entered ***before*** using any other bandwidth reservation configuration commands. If you have exited the bandwidth reservation prompt and wish to return to make bandwidth reservation changes to a previously configured interface, this command must again be entered first.
2. If WAN Restoral is used and BRS is configured on a primary interface, BRS should also be configured on the secondary interface. Typically when WAN Restoral is used, the secondary interface takes on the identity of the primary interface. This is not true for BRS; therefore, BRS needs to be configured on both the primary and secondary interfaces.

To enable Bandwidth Reservation on a particular interface, at the `BRS Config>` prompt, enter the number of the interface that supports the particular protocol or feature. You can then use the BRS **enable** configuration command as described in this chapter. After enabling the interface number, you must reload the 2212 for the command to take effect before you can make any other configuration changes to the interface.

Notes:

1. If you are configuring BRS on a Frame Relay interface, you can use the **circuit** command to select circuits and enable bandwidth reservation on those circuits before you reload the router.

List

Use the **list** command to display currently defined bandwidth classes and their guaranteed percentage rates.

The **list** command and **show** command are similar. The **list** command displays the current SRAM definitions and the **show** command displays the current RAM definitions.

Syntax:

list *interface#*

Depending on the prompt at which you issue the **list** command, various outputs are displayed. You can issue the **list** command from the following prompts:

- `BRS [i 1] [dlci 16] Config>`
- `BRS [i 1] Config>`
- `BRS Config>`
- `BRS [i 1] [circuit defaults] Config>`

Note: When you use this command from a Frame Relay circuit prompt (`BRS [i x] [dlci y] Config>`) it indicates if the circuit is using default circuit definitions or circuit-specific definitions for traffic class handling. If the circuit is using default circuit definitions, the traffic class, protocol, filter, and tag assignments currently defined for default circuit definitions are displayed. However, if you want to alter the default circuit definitions, you need to get to the `BRS[i x] [circuit defaults] Config>` prompt to make changes.

At the BRS interface level prompt (`BRS [i 0]`) for PPP interfaces and at the BRS circuit level prompt (`BRS [i 0] [dlci 16] Config>`) for Frame Relay interfaces, the **list** command lists the traffic classes, their configured bandwidth percentages, and the assigned protocols and filters.

At the BRS interface level prompt for Frame Relay, the **list** command lists the circuit classes, their configured bandwidth percentages, and the assigned circuits.

Example 1

```
BRS Config>list
 Bandwidth Reservation is available for 2 interfaces.

 Interface   Type            State
 ---------   ----            -----
         1   FR              Enabled
         2   PPP             Enabled

 The use of HPR over IP port numbers is disabled

 BRS Config>interface 1
 BRS [i 1] Config>list

 BANDWIDTH RESERVATION listing from SRAM
 bandwidth reservation is enabled
 interface number 1
 maximum queue length 10, minimum queue length 3
 total bandwidth allocated 10%
 total circuit classes defined (counting one default) 1


 class DEFAULT has 10% bandwidth allocated
   the following circuits are assigned:
        17
        16  using defaults.
        18  using defaults.

 default class is DEFAULT

 BRS [i 2] Config>exit
 BRS Config>interface 2
 BRS [i 2] Config>list

 BANDWIDTH RESERVATION listing from SRAM
 bandwidth reservation is enabled
 interface number 2
 maximum queue length 10, minimum queue length 3
 total bandwidth allocated 50%
 total classes defined (counting one local and one default) 2


 class LOCAL has 10% bandwidth allocated
   protocols and filters cannot be assigned to this class.


 class DEFAULT has 40% bandwidth allocated
   the following protocols and filters are assigned:
     protocol IP with default priority
     protocol ARP with default priority
     protocol DNA with default priority
     protocol VINES with default priority
     protocol IPX with default priority
     protocol OSI with default priority
     protocol AP2 with default priority
     protocol ASRT with default priority

 assigned tags:
```

```
 default class is DEFAULT with priority NORMAL

 BRS [i 2] Config>
```

Example 2

```
 BRS [i 1] [dlci 17] Config>list

BANDWIDTH RESERVATION listing from SRAM
bandwidth reservation is enabled
maximum queue length 10, minimum queue length 3
total bandwidth allocated 60%
total classes defined (counting one local and one default) 3


class LOCAL has 10% bandwidth allocated
  protocols and filters cannot be assigned to this class.


class DEFAULT has 40% bandwidth allocated
  the following protocols and filters are assigned:
   protocol ASRT with priority NORMAL is not discard eligible
   filter NETBIOS with priority NORMAL is not discard eligible


class CLASS1 has 10% bandwidth allocated
  the following protocols and filters are assigned:
   protocol IP with priority NORMAL is not discard eligible
   protocol ARP with priority NORMAL is not discard eligible
   protocol DNA with priority NORMAL is not discard eligible
   protocol VINES with priority NORMAL is not discard eligible
   protocol IPX with priority NORMAL is discard eligible
   protocol OSI with priority NORMAL is not discard eligible
   protocol AP2 with priority NORMAL is not discard eligible
```

Example 3

```
 BRS [i 1] [circuit defaults] Config>list

 BANDWIDTH RESERVATION listing from SRAM
 bandwidth reservation is enabled
 interface number 1, default circuit
 maximum queue length 10, minimum queue length 3
 total bandwidth allocated 70%
 total classes defined (counting one local and one default) 4


 class LOCAL has 10% bandwidth allocated
   protocols and filters cannot be assigned to this class.



 class DEFAULT has 40% bandwidth allocated
   the following protocols and filters are assigned:
     protocol DNA with default priority is not discard eligible
     protocol VINES with default priority is not discard eligible
     protocol IPX with default priority is not discard eligible
     protocol OSI with default priority is not discard eligible
     protocol AP2 with default priority is not discard eligible
     protocol ASRT with default priority is not discard eligible


 class DEF1 has 10% bandwidth allocated
   protocol IP with priority NORMAL is not discard eligible.


 class DEF2 has 10% bandwidth allocated
  protocol ARP with priority NORMAL is not discard eligible.

 assigned tags:

 default class is DEFAULT with priority NORMAL

  BRS [i 1] [circuit defaults] Config>
```

Example 4

```
BRS Config>list
 Bandwidth Reservation is available for 2 interfaces.

 Interface   Type            State
 ---------   ----            -----
         1   FR              Enabled
         2   PPP             Enabled

 The use of HPR over IP port numbers is enabled.
```

```
Transmission Type   Port Number
-----------------   -----------
    XID exchange        12000
    HPR network         12001
    HPR high            12002
    HPR medium          12003
    HPR low             12004
```

Queue-length

Use the **queue-length** command to set the number of packets that can be queued in each BRS priority queue. Each BRS class has a priority value assigned to its protocols, filters, and tags, and each priority queue can store the number of packets that you specify with this command.

Syntax:

queue-length *maximum-length minimum-length*

This command sets the maximum number of buffers that can be queued in each BRS priority queue as well as the maximum number that can be queued in each BRS priority queue when there is a shortage of router input buffers.

If you issue **queue-length** for a PPP interface, the command sets the queue-length values for each priority queue of each BRS t-class that is defined for the interface.

If you issue **queue-length** for a Frame Relay interface (at the prompt: `BRS [i 0] Config>`), the command sets the default queue-length values for each priority queue of each BRS t-class that is defined for each permanent virtual circuit of the interface.

If you issue **queue-length** for a Frame-Relay PVC (at a prompt like this: `BRS [i 0] [dlci 16] Config>`) the command sets the queue length values for each priority queue of each BRS t-class that is defined for the PVC. These values override the default queue length values set for the Frame Relay interface.

Attention: Do not use this command unless it is essential to do so. The default values for queue length are the recommended values for most users. If you set the values for queue length too high, you may seriously degrade the performance of your router.

Set-circuit-defaults

Use the **set-circuit-defaults** command to access the commands used to define default circuit definitions for traffic class handling. These default circuit definitions can then be used by any Frame Relay circuits on the interface that can use the same traffic classes and protocol, filter, and tag assignments.

Syntax:

set-circuit-defaults

Show

Use the **show** command to display currently defined bandwidth classes stored in RAM.

Syntax:

show *interface#*

Depending on the prompt at which you issue the **show** command, various outputs are displayed. You can issue the **show** command from the following prompts:

- `BRS [i x] Config>` - interface level prompt for interface number *x*.
- `BRS [i x] [dlci y] Config>` - circuit level prompt for circuit *y* on Frame Relay interface number *x*. The following example shows the output of the show command from the circuit level prompt.

```
BRS [i 1] [dlci 17] Config>show

Protocol/Filter      Class              Priority    Discard Eligible
---------------      -----              --------    ----------------
IP                   CLASS1               NORMAL             NO
ARP                  CLASS1               NORMAL             NO
DNA                  CLASS1               NORMAL             NO
VINES                CLASS1               NORMAL             NO
IPX                  CLASS1               NORMAL             YES
OSI                  CLASS1               NORMAL             NO
AP2                  CLASS1               NORMAL             NO
ASRT                 DEFAULT              NORMAL             NO
NETBIOS              DEFAULT              NORMAL             NO
```

At the interface prompt for PPP and the circuit prompt for Frame Relay, traffic class information is displayed. At the interface prompt for Frame Relay, circuit class information is displayed.

Notes:

1. When you use this command from a Frame Relay circuit prompt (`BRS [i x] [dlci y] Config>`) it indicates if the circuit is using default circuit definitions or circuit-specific definitions for traffic class handling. If the circuit is using default circuit definitions, the traffic class, protocol, filter, and tag assignments currently defined for default circuit definitions are displayed. However, if you want to alter the default circuit definitions, you need to get to the `BRS [i x] [circuit defaults] Config>` prompt to make changes.
2. This command cannot be used from the `BRS [i x] [circuit defaults] Config>` prompt.

Tag

Use the **tag** command to assign a MAC filter item that has been tagged during the configuration of the MAC filtering feature to the next available BRS tag name. The BRS tag names are TAG1, TAG2, TAG3, TAG4, and TAG5. You use the BRS tag name on the assign command to assign the tag to a BRS traffic class.

Syntax:

tag *mac_filter_tag#*

Use the **list** command to list which MAC filter tags have been assigned to a BRS tag name and which BRS tag names have been assigned to a bandwidth traffic class.

Note: If this command is used for a Frame Relay circuit that is currently using default circuit definitions for traffic class handling, you will be asked whether or not you want to override the default circuit definitions. If you answer “Yes”, the circuit will be changed to use circuit-specific definitions for traffic class handling and the command will be allowed. If you answer “No,” the command is aborted and default circuit definitions will continue to be used

for the circuit. If you want to change the default circuit definitions, you should go to the BRS [i x][circuit defaults]Config> command prompt.

Untag

Use the **untag** command to remove the MAC filter tag number and BRS tag name relationship. A tag can be removed only if its corresponding BRS tag name is not assigned to a bandwidth traffic class.

Syntax:

untag *mac_filter_tag#*

Use the **list** command to show which MAC filter tags are assigned to a BRS tag name and which BRS tag names are assigned to a traffic class.

Note: If this command is used for a Frame Relay circuit that is currently using default circuit definitions for traffic class handling, you will be asked whether or not you want to override the default circuit definitions. If you answer “Yes”, the circuit will be changed to use circuit-specific definitions for traffic class handling and the command will be allowed. If you answer “No”, the command is aborted and default circuit definitions will continue to be used for the circuit. If you want to change the default circuit definitions, you should go to the BRS [i x][circuit defaults]Config> command prompt.

Use-circuit-defaults

Use the **use-circuit-defaults** command at the circuit level to delete the circuit-specific definitions and use the circuit default definitions for traffic-class handling. You will be prompted to confirm that you want to use the circuit defaults.

Syntax:

use-circuit-defaults

Notes:

1. This command is used only when configuring Frame Relay
2. The router must be reloaded for the defaults to become operational.

Example:

```
BRS [i 1] [dlci 17] Config>use-circuit-defaults
This circuit is currently NOT using circuit defaults...
 Are you sure you want to delete current definitions and use defaults ? (Yes or
 [No]): y
 Defaults are in effect for this circuit.
 Please reload  router for this command to take effect.
 BRS [i 1] [dlci 17] Config>
```

Accessing the Bandwidth Reservation Monitoring Prompt

To access bandwidth reservation monitoring commands and to monitor bandwidth reservation on your router, do the following:

1. At the OPCON prompt (*), type **talk 5**.
2. At the GWCON prompt (+), type **feature brs.**
3. At the BRS> prompt, type **interface #**, where # is the number of the interface that you want to monitor. This takes you to the BRS interface-level prompt, BRS [i x]>, where x is the interface number.

4. For Frame Relay only, type **circuit #** at the interface prompt to specify the circuit on this interface that you want to monitor.

   This takes you to the circuit-level prompt `BRS [i x] [dlci y]>`, where `x` is the interface number and `y` is the circuit number.

5. At the prompt, type the appropriate monitoring command. (Refer to "Bandwidth Reservation Monitoring Commands".)

   The **talk 5 (t 5)** command lets you access the monitoring process.

   The **feature brs** command lets you access the BRS monitoring process. You can enter this command by using either the feature name (brs) or number (1).

   The **interface #** command selects the particular interface that you want to monitor for bandwidth reservation.

   The **circuit #** command selects the DLCI of a Frame Relay permanent virtual circuit (PVC).

   To return to the GWCON prompt at any time, type the **exit** command at the `BRS>` prompt.

   Once you access the bandwidth reservation monitoring prompt (`BRS>`), you can enter any of the specific monitoring commands described in Table 4.

Bandwidth Reservation Monitoring Commands

This section summarizes and explains the Bandwidth Reservation monitoring commands. 4 shows the Bandwidth Reservation monitoring commands. The commands that can be used differ depending on the BRS monitoring prompt (`BRS>`, `BRS [i x]>`, or `BRS [i x] [dlci y]>`).

Table 4. Bandwidth Reservation Monitoring Command Summary

Command	Used Only With FR	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 xxvi
Circuit	yes	Selects the DLCI of a Frame Relay permanent virtual circuit (PVC). To monitor Frame Relay bandwidth reservation traffic, you must be at the circuit prompt level.
Clear		Clears the current t-class counters and stores them as **last** t-class counters. Counters are listed by class.
Clear-circuit-class	yes	Clears the current c-class counters and stores them as **last** c-class counters. Counters are listed by class.
Counters		Displays the current t-class counters.
Counters-circuit-class	yes	Displays the current c-class counters.
Interface		Selects the interface to monitor. **Note:** This command must be entered before using any other bandwidth reservation monitoring commands.
Last		Displays the last saved t-class counters.
Last-circuit-class	yes	Displays the last saved c-class counters.
Exit		Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi

Circuit

Note: Used only when monitoring Frame Relay.

Use the **circuit** command to select the DLCI of a Frame Relay PVC for monitoring. This command can be issued only from the BRS interface monitoring prompt (`BRS [i #]>`).

Syntax:

circuit *permanent-virtual-circuit-#*

After the Frame Relay circuit has been selected, the following commands can be used at the circuit prompt:

```
CLEAR
COUNTERS
LAST
EXIT
```

Clear

Use the **clear** command to save the current bandwidth reservation t-class counters so that they can be retrieved using the **last** command and clear the values. The counters are kept on a bandwidth traffic class basis.

Syntax:

clear

Clear-Circuit-Class

Note: Used only when monitoring Frame Relay.

Use the **clear-circuit-class** command to save the current bandwidth reservation c-class counters so that they can be retrieved using the **last-circuit-class** command and clear the values. The counters are kept on a circuit class basis.

Syntax:

clear-circuit-class

Counters

Use the **counters** command to display statistics describing bandwidth reservation traffic for the traffic classes configured for a PPP interface or Frame Relay circuit.

Syntax:

counters

Example:

counters

```
Bandwidth Reservation Counters
Interface 1

Class         Pkt Xmit     Bytes Xmit     Bytes Ovfl
LOCAL                0              0              0
DEFAULT              1             30              0
CLASS 1              1             56              0
```

```
CLASS 2              0             0             0
TOTAL                2            86             0
```

Note: The Bytes Ovfl column lists the number of bytes for packets that could not be transmitted because either the maximum queue-length was reached for a priority queue or the packet could not be queued because the priority queue was at the minimum queue length threshold and the packet came from an interface that was running low on receive buffers.

Counters-Circuit-Class

Note: Used only when monitoring Frame Relay.

Use the **counters-circuit-class** command to display statistics for the traffic classes configured for a Frame Relay circuit.

Syntax:

counters-circuit-class

Example:

```
counters-circuit-class

Bandwidth Reservation Circuit Class Counters
Interface 1


Class         Pkt Xmit     Bytes Xmit     Bytes Ovfl
DEFAULT             25           3402             26
CIRCLASS1            1             56              0
CIRCLASS2            0              0              0

TOTAL               26           3458             26
```

Interface

Use the **interface** command to select the serial interface to which bandwidth reservation monitoring commands will be applied. *Bandwidth reservation is supported on routers running the PPP (Point-to-Point Protocol) and Frame Relay interfaces.*

Syntax:

interface *interface#*

Note: To enter bandwidth reservation commands for a new interface, this command must be entered before using any other bandwidth reservation monitoring commands. If you have exited the bandwidth reservation monitoring prompt (BRS>) and want to return to monitor bandwidth reservation, you must again enter this command first.

To monitor Bandwidth Reservation on a particular interface, at the BRS> monitoring prompt, type the number of the interface. You can then use bandwidth reservation monitoring commands as described in this chapter.

Last

Use the **last** command to display the last saved t-class statistics. The t-class statistics are displayed in the same format as they are for the **counters** command.

Syntax:

last

Last-Circuit-Class

Note: Used only when monitoring Frame Relay.

Use the **last-circuit-class** command to display the last saved circuit class statistics. The c-class statistics are displayed in the same format as they are for the **counters-circuit-class** command.

Syntax:

last-circuit-class

Monitoring BRS

Chapter 3. Using MAC Filtering

This chapter describes how to use medium access control (MAC) for specifying packet filters to be applied to packets during processing. It includes the following sections:

- "MAC Filtering and DLSw Traffic"
- "MAC Filtering Parameters" on page 46

Filters are a set of rules applied to a packet to determine how the packet should be handled during bridging. MAC filtering affects only bridged traffic.

Note: MAC Filtering is allowed on tunnel traffic.

During the filtering process, packets are processed, filtered, or tagged during bridging. The actions are:

- **Processed** – Packets are permitted to pass unaffected through the bridge.
- **Filtered** – Packets are not permitted to pass through the bridge.
- **Tagged** – Packets are allowed to pass through the bridge, but are marked with a number in the range 1 through 64 based on a configurable parameter.

A MAC filter consists of the following three objects:

1. Filter-item – which is a single rule that is applied to the address field or an arbitrary window of data within a packet. The result of applying the rule is either a true (successful match) or false (no match) condition.
2. Filter-list – which contains a list of one or more filter-items.
3. Filter – which contains a set of filter-lists.

MAC Filtering and DLSw Traffic

You can filter incoming LLC traffic for the DLSw network by implementing MAC Filtering.

To set up a filter for LLC, use the *Bridge Net* number as the interface number for the filter. Determine the Bridge Net number by adding two to the number of interfaces configured for your router. Enter the **list devices** command at the `Config>` prompt, or enter **configuration** at the + prompt to see a list of interfaces.

In the following example, the Bridge Net number is 7.

```
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
```

When you set up a filter for the Bridge Net, for example, the router does not drop frames that match exclusive filters. Instead, it forwards those frames to the bridge.

MAC Filtering Parameters

You can specify some or all of the following parameters to create a filter:

- Source MAC address or destination MAC address
- Data to be matched within the packet
- Mask to be applied to the packet's fields to be filtered
- Interface number
- Input/Output designation
- Include/Exclude/Tag designation
- Tag value (if the tag designation is given)

Filter-Item Parameters

The following parameters are used to construct an address-filter-item:

- Address Type: SOURCE or DESTINATION
- Tag: a *tag-value*
- Address Mask: a *hex-mask*

Each filter-item specifies an address type (either SOURCE or DESTINATION) to match against the type in the packet.

The address mask is a string of numbers entered in hex, which is used in comparing the packet's addresses. The mask is applied to the SOURCE or DESTINATION MAC address of the packet before comparing it against the specified MAC address.

The address mask must be of equal length to the MAC address and specifies the bytes that are to be logically ANDed with the bytes in the MAC address before the equality comparison to the specified MAC address is made. If no mask is specified, it is assumed to be all 1s.

Filter-List Parameters

The following parameters are used to construct a filter-list:

- Name: an *ASCII-string*
- Filter-item list: *filter-item 1* . . . *filter-item n*
- Action: INCLUDE, EXCLUDE, TAG(*n*)

A filter-list is built from one or more filter-items. Each filter-list is given a unique name.

Applying a filter-list to a packet consists of comparing each filter-item in the order in which the filter-items were added to the list. If any filter-item in the list returns a TRUE condition then the filter-list will return its designated action.

Filter Parameters

The following parameters are used to construct a filter:

- Filter-list names: *ASCII-string 1* . . . *ASCII-string n*
- Interface number: an *IFC-number*

- Port direction: INPUT or OUTPUT
- Default action: INCLUDE, EXCLUDE, or TAG
- Default tag: a *tag-value*

A filter is constructed by associating a group of filter-list names with an interface number and assigning an INPUT or OUTPUT designation. The application of a filter to a packet means that each of the associated filter-lists should be applied to packets being received (INPUT) or sent (OUTPUT) on the specified numbered interface.

When a filter evaluates a packet to an INCLUDE condition, the packet is forwarded. When a filter evaluates a packet to an EXCLUDE condition, the packet is dropped. When a filter evaluates to a TAG condition, the packet being considered is forwarded with a tag.

An additional parameter of each filter is the default action, which is the result of non-match for all of its filter-lists. This default action is INCLUDE. It can be set to INCLUDE, EXCLUDE, or TAG. In addition, if the default action is TAG, a tag value is also given.

Using MAC Filtering Tags

The following list includes some uses of MAC filtering tags

- MAC Address filtering is handled jointly by bandwidth reservation and the MAC Filtering feature (MCF) using tags. A user with bandwidth reservation is able to categorize bridge traffic, for example, by assigning a tag to it.
- The tagging process is done by creating a filter-item in the MAC Filtering configuration console and then assigning a tag to it. This tag is then used to set up a bandwidth class for all packets associated with this tag. Tag values must currently be in the range 1 to 64.
- Once a tagged filter has been created in the MAC Filtering configuration process, the Bandwidth Reservation (BRS) **tag** configuration command is used to assign a BRS tag name (TAG1, TAG2, TAG3, TAG4, or TAG5) to the MAC filter tag number. The BRS tag name is then used on the BRS **assign** configuration command to assign the corresponding MAC filter to a bandwidth traffic class and priority.
- Up to 5 tagged MAC addresses can be set from 1 to 5. TAG1 will be searched for first, then TAG2, all the way to TAG5.

Tags can also refer to “groups” in IP Tunnel. IP Tunnel end-points can belong to any number of groups, with packets assigned to a particular group through the tagging feature of MAC address filtering.

Chapter 4. Configuring and Monitoring MAC Filtering

This chapter describes how to access the MAC Filtering configuration and monitoring prompts and how to use the available commands. It includes the following sections:

Accessing the MAC Filtering Configuration Prompt

Use the **feature** command from the CONFIG process to access the MAC filtering configuration commands. The **feature** command lets you access configuration commands for specific features outside the protocol and network interface configuration processes.

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

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

To access the MAC filtering configuration prompt, enter the **feature** command followed by the *feature number* (3) or *short name* (MCF). For example:

```
Config> feature mcf
MAC Filtering user configuration
Filter config>
```

Once you access the MAC filtering configuration prompt, you can begin entering specific configuration commands. To return to the CONFIG prompt at any time, enter the **exit** command at the MAC filtering configuration prompt.

MAC Filtering Configuration Commands

This section summarizes the MAC filtering configuration commands. Enter these commands at the `Filter config>` prompt.

Use the following commands to configure the MAC filtering feature.

Table 5. MAC Filtering 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 xxvi.
Attach	Adds a filter list to a filter.
Create	Creates a filter list or an INPUT or OUTPUT filter.
Default	Sets the default action for the specified filter to EXCLUDE, INCLUDE, or TAG.
Delete	Removes all information associated with a filter list. Also deletes a filter that was created using the create filter command.
Detach	Removes a filter list from a filter.
Disable	Disables MAC Filtering entirely or disables a particular filter.
Enable	Enables MAC Filtering entirely or enables a particular filter.

Table 5. MAC Filtering Configuration Command Summary (continued)

Command	Function
List	Lists a summary of all the filter lists and filters configured by the user. Also generates a list of attached filter lists for this filter and all subsequent information for the filter.
Move	Reorders the filter lists attached to a specified filter.
Reinit	Re-initializes the entire MAC Filtering system from an updated configuration, without affecting the rest of the router.
Set-Cache	Changes the cache size for a filter.
Update	Adds or deletes information from a specific filter list. Brings you to a menu of appropriate subcommands.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Attach

Use the **attach** command to add a filter-list to a filter.

A filter is constructed by associating a group of filter-lists with an interface number. A filter-list is built from one or more filter-items.

Syntax:

attach *filter-list-name filter-number*

Create

Use the **create** command to create a filter-list or an INPUT or OUTPUT filter.

Syntax:

create list *filter-list-name*

filter [input or output] *interface-number*

list *filter-list-name*
Creates a filter-list. Lists are named by a unique string (Filter-list-name) of up to 16 characters of the user’s choice. This name is used to identify a filter-list that is being built. This name is also used with other commands associated with the filter-list.

filter [input or output] *interface-number*
Creates a filter and places it on the network associated with the INPUT or OUTPUT direction on the interface given by an interface number. By default this filter is created with no attached filter-lists, has a default action of INCLUDE and is ENABLED.

Default

Use the **default** command to set the default action for the filter with a specified filter number to exclude, include, or tag.

Syntax:

default exclude *filter-number*

include *filter-number*

tag *tag-number filter-number*

exclude *filter-number*
Sets the default action for the filter with a specified filter number to exclude.

include *filter-number*
Sets the default action for the filter with a specified filter number to include.

tag *tag-number filter-number*
Sets the default action for the filter with the specified filter number to TAG and sets the associated tag value to tag number.

Delete

Use the **delete** command to remove all information associated with a filter-list and to free an assigned string as a name for a new filter-list. If filter-list is attached to a filter that has already been created by the user, then this command will display an error message on the console without deleting anything. In addition all filter-items belonging to this list are also deleted

This command also deletes a filter that was created using the **create filter** command.

Syntax:

delete list *filter-list*

filter *filter-number*

list *filter-list*
Removes all information associated with a filter-list and frees an assigned string as a name for a new filter-list. The filter-list must be a string entered by a previous **create list** command.

If the filter-list is attached to a filter that has already been created by the user, then this command will display an error message on the console without deleting anything. All filter-items belonging to this list are also deleted when this command is used.

filter *filter-number*
Deletes a filter that was created using the **create filter** command.

Detach

Use the **detach** command to delete a filter-list name (filter-list parameter) from a filter (filter-number parameter).

Syntax:

detach *filter-list-name filter-number*

Disable

Use the **disable** command to disable MAC Filtering entirely or to disable a particular filter.

Syntax:

disable all

filter *filter-number*

all Disables MAC Filtering entirely. Filters are still set as ENABLED, however, if they were enabled previously.

filter *filter-number*
Disables a particular filter. The filter-number parameter corresponds to the numbers displayed in the **list filters** command.

Enable

Use the **enable** command to enable MAC Filtering entirely or to enable a particular filter.

Syntax:

enable all

filter *filter-number*

all Enables MAC Filtering entirely, although filters themselves may still be set to DISABLED.

filter *filter-number*
Enables a particular filter. The filter-number parameter corresponds to the numbers displayed in the **list filters** command.

List

Use the **list** command to list a summary of all the filter-lists and filters configured by the user. A list of all the filter-lists attached to a filter is not given. Other information displayed includes:

- A list containing the state of the filtering system (ENABLE, DISABLE)
- The set of configured filter-list records
- Each of the configured filter records.

In addition, the following information is displayed for each filter:

- Filter number
- Interface number
- Filter direction (INPUT, OUTPUT)
- Filter state (ENABLE, DISABLE)
- Filter default action (TAG, INCLUDE, EXCLUDE).

This command also generates a list of attached filter-lists for this filter and all subsequent information for the filter.

Syntax:

list all

filter *filter-number*

all Displays a summary of all the configured filter-lists and filters.

filter *filter-number*
Generates a list of attached filter-lists for the specified filter and all subsequent information for the filter.

Move

Use the **move** command to reorder the filter-lists attached to a specified filter (given by filter-number parameter). The list given by Filter-list-name1 is moved immediately before the list given by Filter-list-name2.

Syntax:

move *filter-list-name1 filter-list-name2 filter-number*

Reinit

Use the **reinit** command to re-initialize the entire MAC Filtering system from an updated configuration, without affecting the rest of the router.

Syntax:

reinit

Set-Cache

Use the **set-cache** command to change the default cache size (16) to a number in the range 4 to 32768.

Syntax:

set-cache *cache-size filter-number*

Update

Use the **update** command to add information to or delete information from a specific filter-list. Using this command with the desired filter-list-name brings you to the `Filter filter-list-name Config>` prompt for that specific filter-list. From this new prompt you can then change information in the specified list.

The new prompt level is used to add or delete filter-items from filter-lists. The order in which the filter-items are specified for a given filter-list is important as it determines the order in which the filter-items are applied to a packet.

Syntax:

update *filter-list-name*

Update Subcommands

This section summarizes the MAC filtering configuration subcommands. Enter these subcommands at the `Filter filter-list-name config>` prompt.

Table 6. Update Subcommands Summary

Subcommand	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 xxvi.
Add	Adds source or destination MAC address filters or a window filter. Adds filter-items to a filter-list.
Delete	Removes filter-items from a filter-list.

Table 6. Update Subcommands Summary (continued)

Subcommand	Function
List	Lists a summary of all the filter-lists and filters configured by the user. Also generates a list of attached filter-lists for this filter and all subsequent information for the filter.
Move	Reorders the filter-lists attached to a specified filter.
Set-Action	Sets a filter-item to evaluate the INCLUDE, EXCLUDE or TAG (with a tag-number option) condition.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Use the following subcommands to update a filter-list.

Add

Use the **add** subcommand to add filter-items to a filter-list. This subcommand specifically lets you add a hexadecimal number to compare against the source or destination MAC address, or a sequence of window data with a mask to compare against a packet data.

The order in which the filter-items are added to a given filter-list is important because it determines the order in which the filter-items are applied to a packet.

Each use of the **add** subcommand creates a filter-item within the filter-list. The first filter-item created is assigned filter-item-number 1, the next one is assigned number 2, and so on. After you enter a successful **add** subcommand, the router displays the number of the filter-item just added.

The first match that occurs stops the application of filter-items, and the filter-list evaluates to INCLUDE, EXCLUDE, or TAG, depending on the designated action of the filter-list. If none of the filter-items of a filter-list produces a match, then the default action (INCLUDE, EXCLUDE or TAG) of the filter is returned.

Syntax: add source *hex-MAC-addr hex-Mask*

destination *hex-MAC-addr hex-Mask*

window MAC *offset-value hex-data hex-mask*

window INFO *offset-value hex-data hex-mask*

source *hex-MAC-addr hex-Mask*
Adds a hexadecimal number to compare against the source MAC address. ***hex-MAC-addr*** must be an even number of hex digits with a maximum of 16 digits and should be entered without a 0x in front.

The hex-mask parameter must be the same length as hex-MAC-address and is logically ANDed with the designated MAC address in the packet. The default hex-mask argument is to be all binary 1s.

The hex-MAC-addr parameter can be specified in canonical or noncanonical bit order. A canonical bit order is specified as just a hex number (for example, 000003001234). It may also be represented as a series of hex digits with a hyphen (-) between every two digits (for example, 00-00-03-00-12-34).

A noncanonical bit order is specified as a series of hex digits with a colon (:) between every two digits (for example, 00:00:C9:09:66:49). MAC addresses of filter-items will always be displayed using either a hyphen (-) or a colon (:) to distinguish canonical from noncanonical representations.

destination *hex-MAC-addr hex-Mask*
Acts identically to the add source subcommand, with the exception that the match is made against the destination rather than the source MAC address of the packet.

window MAC *offset-value hex-data hex-mask*
Adds a sliding window filter-item using the specified offset (computed from the beginning of the frame) that matches the hex data with the mask against packet data.

window INFO *offset-value hex-data hex-mask*
Similar to the **add window mac** command, except that the offset is computed with respect to the beginning of the information field.

Delete

Use the **delete** subcommand to remove filter-items from a filter-list. You delete filter-items by specifying the filter-item-number assigned to the item when it was added.

When the **delete** subcommand is used, any gap created in the number sequence is filled in. For example, if filter-items 1, 2, 3, and 4 exist and filter-item 3 is deleted, then filter-item 4 will be renumbered to 3.

Syntax:

delete	*filter-item-number*

List

Use the **list** subcommand to print out a listing of all the filter-item records. The following information about each MAC-Address filter-item is displayed:

- MAC address and address mask in canonical or noncanonical form.
- filter-item numbers
- address type (source or destination)
- filter-list action

Syntax:

list	canonical
	noncanonical
	mac-address canonical
	mac-address noncanonical
	window

canonical
Prints out a listing of all the filter-item records within a filter-list, giving the item numbers, the address type (SRC, DST), the MAC address in canonical form, and the address mask in canonical form. It also gives the filter-list action.

mac-address canonical
Prints out a listing of all the filter-item records within a filter-list, giving the

item numbers, the address type (SRC, DST), the MAC address in canonical form, and the address mask in canonical form. In addition the filter-list action is given.

noncanonical
Prints out a listing of all the filter-item records within a filter-list, giving the item numbers, the address type (SRC, DST), the MAC address in noncanonical form, and the address mask in noncanonical form. It also gives the filter-list action.

mac-address noncanonical
Prints out a listing of all the filter-item records within a filter-list, giving the item numbers, the address type (SRC, DST), the MAC address in noncanonical form, and the address mask in noncanonical form. It also gives the filter-list action.

window
Prints out a listing of all the sliding window filter-item records within a filter-list, giving the item numbers, base, offset, data, and mask. It also gives the filter-list action.

Move

The **move** subcommand reorders filter-items within the filter-list. The filter-item whose number is specified by *filter-item-name1* is moved and renumbered to be just before *filter-item-name2*.

Syntax:

move *filter-item-name1 filter-item-name2*

Set-Action

The **set-action** subcommand lets you set a filter-item to evaluate the INCLUDE, EXCLUDE, or TAG (with a tag-number option) condition. If one of the filter-items of the filter-list matches the contents of the packet being considered for filtering, the filter-list will evaluate to the specified condition. The default setting is INCLUDE.

Syntax:

set-action [INCLUDE or EXCLUDE or TAG] *tag-number*

Accessing the MAC Filtering Monitoring Prompt

Use the **feature** command from the GWCON process to access the MAC filtering monitoring commands. The **feature** command lets you access monitoring commands for specific router features outside of the protocol and network interface monitoring processes.

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

```
+ feature ?
WRS
BRS
MCF
```

To access the MAC filtering monitoring prompt, enter the **feature** command followed by the feature number (3) or short name (MCF). For example:

```
+ feature mcf
MAC Filtering user monitoring
Filter>
```

Once you access the MAC filtering monitoring prompt, you can begin entering specific monitoring commands. To return to the GWCON prompt at any time, enter the **exit** command at the MAC Filtering monitoring prompt.

MAC Filtering Monitoring Commands

This section summarizes the MAC filtering monitoring commands. Enter these commands at the `Filter>` prompt.

Table 7. MAC Filtering 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 xxvi.
Clear	Clears the "per filter" statistics listed in the list filter command.
Disable	Disables MAC Filtering globally or on a "per filter" basis.
Enable	Enables MAC Filtering globally or on a "per filter" basis.
List	Lists a summary of statistics and settings for each filter currently running in the router.
Reinit	Re-initializes the entire MAC Filtering system from an updated configuration, without affecting the rest of the router.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Use the following commands to monitor the MAC filtering feature.

Clear

Use the **clear** command to clear filter statistics.

Syntax:

clear all

filter *filter-number*

all Clears the statistics listed by the **list all** command.

filter *filter-number*
Clears the statistics listed by the **list filter** command.

Disable

Use the **disable** command to disable MAC filtering globally. This command does not individually disable each filter.

The command also disables a filter as specified by filter-number. This filter is disabled without modifying configuration records. If no argument is given, MAC filtering is globally disabled.

Syntax:

disable all

filter *filter-number*

all Disables MAC filtering globally. This command does not individually disable each filter.

filter ***filter-number***
Disables the filter that is specified by the filter number. This filter is disabled without modifying configuration records. If no filter number is given, MAC filtering is globally disabled.

Enable

Use the **enable** command to enable MAC filtering globally. This command does not individually enable each filter.

The command also enables a filter as specified by filter-number. This filter is enabled without modifying configuration records. If no argument is given, MAC filtering is globally enabled.

Syntax:

enable all

filter *filter-number*

all Enables MAC filtering globally. This command does not individually enable each filter.

filter *filter-number*
Enables the filter that is specified by the filter number. This filter is enabled without modifying configuration records. If no filter number is given, MAC filtering is globally enabled.

List

Use the **list** command to list a summary of statistics and settings for each filter currently running in the router. The following information is displayed for each filter when the **list all** command is used:

- Default action
- Cache size
- Default tag
- State (enabled/disabled)
- Number of packets which have been filtered as INCLUDE, EXCLUDE or TAG.

In addition, the following information is also displayed by the **list filter** command for a specified filter:

- All information displayed by the list all command
- All the filter-lists currently running in this filter including:
  - List name
  - List action
  - List tag
  - Number of packets which have been filtered by each filter-list.

Syntax:

list all

filter *filter-number*

all Lists statistics and settings for each filter currently running in the router.

filter *filter-number*
Generates statistics and settings for each filter plus all the filter-lists currently running in this filter.

Reinit

Use the **reinit** command to re-initialize the entire MAC Filtering system from an updated configuration, without affecting the rest of the router.

Syntax:

reinit

Configuring MAC Filtering

Chapter 5. Using WAN Restoral

This chapter includes the following sections:

Overview for WAN Restoral, WAN Reroute, and Dial-on-Overflow

The WAN Restoral, WAN Reroute, and Dial-on-overflow features have similar functions and might be confused. This overview is intended to help you decide which of these functions will be useful to you and to help you find the information you need to configure them.

The configuration commands for all three features are included in the ″Configuring WAN Restoral″ chapter. For additional information about WAN Reroute and Dial-on-overflow see "Chapter 7. The WAN Reroute Feature" on page 81.

WAN Restoral

WAN Restoral is the most basic function. When you use WAN Restoral, you configure a primary and a secondary link. In case the primary link fails, the secondary link is started and assumes the characteristics of the primary. You don't configure any protocol definitions on the secondary link because it uses the protocol definitions from the primary link.

For WAN Restoral:

- There is a pairing between a primary and a secondary link.
- You can configure only one primary to use a specific secondary link.
- You don't configure protocol definitions (for example: protocol addresses) on the secondary link.
- The primary link can be a PPP serial interface or a multilink PPP interface. It can not be a PPP dial circuit interface.
- The secondary link must be a PPP dial circuit or a Multilink-PPP interface.
- You must enable the WRS feature using the **enable wrs** command.
- You must enable the primary/secondary pair using the **enable secondary-circuit** command.

Note: When BRS is configured on a primary link and the primary link is part of a primary-secondary pair for WAN Restoral, you must configure BRS on the secondary link. Typically when WAN Restoral is configured, the secondary link takes the identify of the primary link. However, this is not true for BRS; therefore, BRS needs to be configured on both the primary and secondary link.

WAN Reroute

WAN Reroute is a more advanced function. When you use WAN Reroute, you configure a primary and an alternate link. In case the primary link fails, the alternate link is started. The routing protocols (for example, RIP or OSPF) detect the newly available link and adjust the routes that are used for forwarding packets.

For WAN Reroute:

- There is a pairing between a primary and an alternate link.
- You may configure multiple primary links to use the same alternate link.
- You must configure protocol definitions on the alternate link.
- The primary link may be any link on which you can configure routable protocols (e.g. IP, IPX). For example, the primary link may be a LAN interface, a PPP, Frame Relay, or X.25 serial interface, or a PPP or Frame Relay dial circuit. The following are examples of interface types that cannot be primary links: SDLC serial interfaces, SRLY serial interfaces, and base nets like V.25bis and ISDN.
- The alternate link may be any link on which you can configure routable protocols (e.g. IP, IPX) and the datalink type of the alternate link need not match the datalink type of the primary link. For example, the alternate link may be a LAN interface, a PPP, Frame Relay, or X.25 serial interface, or a PPP or Frame Relay dial circuit. The following are examples of interface types that cannot be alternate links: SDLC serial interfaces, SRLY serial interfaces, and base nets like V.25bis and ISDN.
- If the primary link is a dial circuit then it cannot be a dial-on-demand dial circuit (you must configure 'set idle 0' on the dial circuit). I.430, I.431 and Channelized T1/E1 Dial Circuits are implicitly fixed, and therefore can be used as a WRS Primary.

  Note: I.430/I.431 and Channelized T1/E1 dial circuits can be used as WRS primary without any explicit configuration.
- The alternate link may not be a dial-on-demand dial circuit (you must configure 'set idle 0' on the dial circuit).
- You must enable the WRS feature using the **enable wrs** command.
- You must enable the primary/alternate pair using the **enable alternate-circuit** command.
- You may optionally configure stabilization times and start-and stop-time-of-day-revert-back times to control the switching back to the primary link.
- If the alternate link is X.25, you should use the **national-personality set disconnect-procedure active** command when configuring the X.25 interface of the router that has WAN Reroute enabled and use the **national-personality set disconnect-procedure passive** command when configuring the X.25 interface of the other router.

Dial-on-overflow

Dial-on-overflow is similar to WAN Reroute, but does not require failure of the primary to start the alternate link. Instead, the utilization of the primary link is monitored, and if a threshold is exceeded, the alternate link is started. Also, not all protocols are brought up on the alternate link. Only IP is brought up on the alternate link, and other protocols continue to use the primary link unless the primary link goes down.

If the primary link goes down, WAN Reroute takes over and any protocols configured on the alternate interface can start detecting and using routes on the alternate interface.

For Dial-on-overflow:

- Dial-on-overflow uses the primary/alternate pairing of a WAN Reroute pair.
- You must configure a WAN reroute pair to use Dial-on-overflow, and all the restrictions of WAN Reroute configuration apply.
- The primary link of a WAN Reroute pair that will be used for Dial-on-overflow must be Frame Relay.
- You must use the OSPF routing protocol to use Dial-on-overflow.
- You must use the **enable dial-on-overflow** command to configure add-threshold and drop-threshold, the bandwidth monitoring interval, and the minimum alternate up time.
- Stabilization times and start-time-of-day-revert-back and stop-time-of-day-revert-back times do not affect the operation of dial-on-overflow.

For more information about WAN Reroute see “Chapter 7. The WAN Reroute Feature” on page 81.

Before You Begin

Before you configure WAN Restoral, you must have the following:

1. A primary serial interface (leased line) configured for PPP. You can use any serial interface on the router.
2. An interface with the associated dial circuits configured on the router. You can use an ISDN interface or a V.25bis interface as the base net.
3. A secondary dial circuit configured to dial when the primary interface goes down. To configure a dial circuit to do this, set the idle timer to zero using the **set idle** command at that dial `Circuit Config>`prompt.
4. A secondary dial circuit at one end of the link configured to send calls only. Use the **set calls outbound** command at the `Circuit Config>` prompt.

   Note: Do not configure any protocol addresses on the secondary interface. The protocol assignments for the primary interface are used on the secondary link (dial circuit) when it is active.
5. A secondary dial circuit at the other end of the link configured to receive calls only. Use the **set calls inbound** command at the `Circuit Config>` prompt.

Configuration Procedure for WAN Restoral

This section describes the steps required to configure WAN Restoral. Before you begin, use the **list device** command at the `Config>` prompt to list the interface numbers of different devices.

Follow these steps to configure WAN Restoral on the router:

1. Display the `WRS Config>` prompt by entering the **feature wrs** command at the `Config>` prompt. For example:

```
Config>feature wrs
WAN Restoral user configuration
WRS Config>
```

2. Assign a secondary dial circuit to the primary interface. This dial circuit will back up the primary interface. For example:

```
WRS Config>add secondary-circuit
Secondary interface number  [0]? 3
Primary interface number  [0]? 1
```

3. Enable WAN Restoral on the secondary dial circuit that you added. For example:

```
WRS Config>enable secondary-circuit
Secondary interface number  [0]? 3
```

4. Globally enable WAN Restoral on the router. For example:

```
WRS Config>enable wrs
```

5. Restart the router for configuration changes to take effect.

Secondary Dial Circuit Configuration

To configure a dial circuit:

1. Determine the dial-circuit interface number: To do this, type:

```
Config> list device
```

   If no PPP dial-circuit interface is listed, add a dial-circuit interface by typing:

```
Config> add device dial-circuit

Adding device as interface 3
Defaulting Data-link protocol to PPP
Use "net 3" command to configure circuit parameters
```

2. Configure the secondary interface (dial circuit) to have the same datalink type as the primary interface (PPP) from the `Config>` prompt as follows:

```
Config> set data PPP
Interface Number [0]? 3
```

3. Access the dial circuit configuration prompt (`Circuit Config>`) by entering **network** *interface#*.

```
Config> network 3
```

4. Select the base net interface for the dial circuit. The base net can be V.25bis, or ISDN.

```
Circuit Config> set net 2
```

5. Set the dial circuit idle timer to 0 (0=fixed) as follows:

```
Circuit Config> set idle 0
```

6. Set one end of the backup connection to receive calls (for example, router A) as follows:

```
Circuit Config> set calls inbound
```

7. Set the other end of the backup connection to initiate calls (for example, router B) as follows:

```
Circuit Config> set calls outbound
```

Notes:

1. Do not use the **set calls both** command. Setting these individually will help prevent the collisions of incoming and outgoing connection attempts.
2. Do not configure any forwarder (for example, IP, IPX, etc.) addresses on the dial circuit. The protocol assignments for the primary interface are used on the secondary interface (dial circuit) when it is active.
3. For ISDN configuration instructions, see 'Using the ISDN Interface' in *Access Integration Services Software User's Guide*.
4. For V.25bis configuration instructions, see 'Using the V.25bis Interface' in *Access Integration Services Software User's Guide*.

Chapter 6. Configuring and Monitoring WAN Restoral

This chapter describes the WAN Restoral configuration and operational commands. It includes the following sections:

WAN Restoral, WAN Reroute, and Dial-on-Overflow Configuration Commands

The WAN Restoral configuration commands allow you to create or modify the WAN Restoral interface configuration. This section summarizes and explains the WAN Restoral configuration commands.

Table 8 lists the WAN Restoral configuration commands and their function. Enter these commands at the `WRS Config>` prompt. To access `WRS Config>`, enter **feature wrs** at the `Config>` prompt.

Table 8. WAN Restoral 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 xxvi.
Add	Adds a mapping of primary-to-secondary (for WAN Restoral) or primary-to-alternate (for WAN Reroute).
Disable	Disables WRS, an individual secondary-circuit mapping, or alternate-circuit mapping.
Enable	Enables WRS, an individual secondary-circuit mapping, or alternate-circuit mapping.
List	Displays the current Restoral configuration.
Remove	Removes a primary to secondary mapping or a primary to alternate mapping created by add.
Set	Sets the values for the stabilization and time-of-day-revert-back timers.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Add

Use the **add** command to identify a secondary or an alternate dial-circuit or leased link interface for a primary serial link.

Syntax:

add alternate-circuit

secondary-circuit

alternate-circuit

The **add alternate-circuit** command binds an alternate interface to a primary interface for WAN Reroute purposes. You can assign multiple primaries to a single alternate interface. The alternate link type need not be

the same as the primary link type (for example, the alternate link type can be a PPP dial circuit and the primary link type can be a Frame Relay leased line).

Example:

```
WRS Config>add alt
Alternate interface number  [0]? 6
Primary interface number  [0]? 1
```

Alternate interface number
This is the interface number previously assigned to the alternate interface. Any LAN interface, PPP, Frame Relay, or X.25 serial interface, or a PPP or Frame Relay dial circuit is an eligible alternate interface. The default is 0.

Primary interface number
This is the interface number of the primary interface previously assigned when the device was added. A primary interface can be any previously defined LAN interface, PPP, Frame Relay, or X.25 serial interface, or a PPP or Frame Relay dial circuit. The default is 0.

secondary-circuit
The **add secondary-circuit** command binds a secondary interface to a primary interface for WAN Restoral purposes. Both interfaces must have previously been configured. You can only assign one secondary interface to a primary and vice-versa.

Example:

```
WRS Config>add secondary-circuit
Secondary interface number  [0]? 4
Primary interface number  [0]? 1
```

Secondary interface number
This is the dial circuit interface number previously assigned to the secondary interface when the device was added. Any PPP dial circuit or Multilink PPP interface can be a secondary interface. The default is 0.

Primary interface number
This is the interface number of the primary interface previously assigned when the device was added. A primary interface can be any previously defined leased-line running PPP. The default is 0.

Disable

Use the **disable** command to disable the WAN Restoral function, or to disable a primary/secondary pairing for WAN Restoral, or to disable a primary/alternate pairing for WAN Reroute, or to disable Dial-on-overflow for a primary/alternate pairing.

Syntax:

disable alternate-circuit
dial-on-overflow
secondary-circuit
wrs

alternate-circuit *interface#*
Disables the primary/alternate pairing for WAN Reroute.

Example:

```
WRS Config> disable alternate-circuit
Alternate interface number  [0]? 6
```

Alternate interface number
This is the number of the alternate interface previously configured with the **add alternate-circuit** command. The default is 0.

dial-on-overflow *alt-intfc#*
Disables dial-on-overflow for all primary/alternate pairings using a specified alternate.

Example:

```
WRS Config> disable dial-on-overflow
alternate interface number  [0]? 6
```

Alternate interface number
This is the number of the alternate interface previously configured with the **add alternate-circuit** command. The default is 0.

secondary-circuit *interface#*
Disables the restoral of a particular primary interface by its associated secondary interface until the next **enable secondary-circuit** command at the WRS console. Both interfaces must have been previously configured and bound together in the WRS configuration.

Example:

```
WRS Config> disable secondary-circuit
Secondary interface number  [0]? 3
```

Secondary interface number
This is the number of the secondary interface previously configured with the **add secondary-circuit** command. The default is 0.

wrs Disables the WAN Restoral feature globally on the router. This means that WAN Reroute and Dial-on-overflow are also disabled.

Enable

Use the **enable** command to enable the WAN Restoral function, to enable a primary/secondary pairing for WAN Restoral, to enabled a primary/alternate pairing for WAN Reroute, or to enable dial-on-overflow for a primary/alternate pairing.

Syntax:

enable alternate-circuit
dial-on-overflow
secondary-circuit
wrs

alternate-circuit *interface#*
Enables an alternate circuit

Example:

```
WRS Config>enable alternate-circuit
Alternate interface number  [0]? 6
```

Alternate interface number
This is the number of the alternate interface previously configured with the **add alternate-circuit** command. The default is 0.

dial-on-overflow

Enables dial-on-overflow and allows you to set parameters that control how dial-on-overflow works.

Example:

```
WRS>enable dial-on-overflow

For dial-on-overflow, only IP traffic can overflow to the alternate
interface.
Primary interface number  ]0]? 1
add-threshold (1-100% utilization) [90]?
drop-threshold(0-99% utilization) [60]?
bandwidth test interval(10-200 seconds) [15]?
minimum time to keep the alternate up (20-21600 sec.) [300]?
Dial-on overflow is enabled.
Remember to configure the primary interface's line speed!
```

Primary interface number

This is the interface number of the primary interface for which you are enabling dial-on-overflow. The default is 0.

add-threshold

Determines when an alternate interface will be brought up for additional bandwidth. This value must expressed as a percentage of the primary interface's configured line speed. The default is 90%.

drop-threshold

Determines when an alternate interface is no longer needed for additional bandwidth. This value must expressed as a percentage of the primary interface's configured line speed. The default is 60%.

bandwidth monitoring interval

Determines how often the primary interface's bandwidth is monitored for the *add-threshold* and *drop-threshold.* The default is 15 seconds.

Minimum time to keep alternate up

This time period needs to include enough time for the routers to establish the new route when IP traffic on the local router is rerouted to the alternate interface. The default is 5 minutes.

secondary-circuit *interface#*

Enables the restoral of a primary link by the indicated secondary link.

Example:

```
WRS Config>enable secondary-circuit
Secondary interface number  [0]? 3
```

Secondary interface number

This is the number of the secondary interface previously configured with the **add secondary-circuit** command. The default is 0.

wrs Enables the function of the WAN Restoral feature on the router. This means that if WAN Reroute and Dial-on-overflow are configured they are also enabled.

List

Use the **list** command to display global configuration information for the feature and display configuration information for WAN Restoral primary-secondary pairs, WAN Reroute primary-alternate pairs, and Dial-on-Overflow.

Syntax:

list

Example:

```
WRS Config>list
WAN Restoral is enabled.
Default Stabilization Time:       0 seconds
Default First Stabilization Time: 0 seconds

                                                  Secondary
   Primary Interface       Secondary Interface    Enabled
----------------------  ----------------------  --------
 4 - WAN PPP             7 - PPP Dial Circuit       No
                                          Alt.     1st  Subseq TOD Revert Back
Primary Interface  Alternate Interface    Enabled  Stab  Stab  Start    Stop
-----------------  ---------------------  -------  ----  ----  -------  -------

 1 - WAN Frame Re   2 - WAN Frame Relay      Yes    dflt  dflt  Not Set  Not Set


Dial-on-overflow is enabled.
Primary    add-       drop-      test       minimum
Interface  threshold  threshold  interval   alt up time
---------  ---------  ---------  ---------  -----------
     1         29%        20%      15 sec.   300 sec.
```

Remove

Use the **remove** command to delete the mapping of an alternate interface or secondary (backup) interface to the primary interface.

Syntax:

remove alternate-circuit
secondary-circuit

alternate-circuit *alternate-interface# primary-interface#*

Removes the mapping of a alternate (backup) interface to the primary interface for WAN Reroute. Both interfaces must have been previously assigned and bound together using the **add alternate-circuit** command.

Alternate-interface#

This is the number of the alternate interface previously configured with the **add alternate-circuit** command. The default is 0.

Primary-interface#

This is the interface number of the primary interface previously bound to the alternate being removed. The default is 0.

Example:

```
WRS Config> remove alternate-circuit
Alternate interface number  [0]? 3
Primary interface number  [0]? 1
```

secondary-circuit *secondary-interface# primary-interface#*

Removes the mapping of a secondary (backup) interface to the primary interface for WAN Restoral. Both interfaces must have been previously assigned and bound together using the **add secondary-circuit** command.

Secondary-interface#

This is the number of the secondary interface previously configured with the **add secondary-circuit** command. The default is 0.

Primary-interface#

This is the interface number of the primary interface previously bound to the secondary being removed. The default is 0.

Example:

```
WRS Config> remove secondary-circuit
Secondary interface number  [0]? 3
Primary interface number  [0]? 1
```

Set

Use the **set** command to set the parameters for WAN Reroute.

Syntax:

set ? default
first-stabilization
stabilization
start-time-of-day-revert-back
stop-time-of-day-revert-back

default

Use the **set default** command to set the defaults to be used by links that do not have configured stabilization and first-stabilization times.

first-stabilization

Sets the default first-stabilization value to be used for links for which a first-stabilization time was not configured.

```
WRS Config>set default first
Default first primary stabilization time (0 - 3600 seconds)  [0]? 20
```

stabilization

Sets the default stabilization value to be used for links for which a stabilization time was not configured.

```
WRS Config>set default stab
 Default primary stabilization time (0 - 3600 seconds)  [0]? 30
```

first-stabilization

Sets the number of seconds at router initialization before routing for this primary link is switched to the alternate link if the primary link is not up.

Example:

```
WRS Config>set first
Primary interface number  [0]? 1
First primary stabilization time (0 - 3600 seconds -1 = default)  [-1]?
```

Primary interface number

This is the primary interface number of the primary interface for which you are setting first-stabilization. The default is 0.

First primary stabilization time

The stabilization time for this primary interface. The default is 1.

stabilization

Sets the number of seconds required after the primary link is first detected to be up before routing is switched back to the primary. Routing over the alternate link continues until the primary link remains up for this number of seconds.

Example:

```
WRS Config>set first
Primary interface number  [0]? 1
Primary stabilization time (0 - 3600 seconds -1 = default)  [-1]?
```

Primary interface number

This is the primary interface number of the primary interface for which you are setting stabilization. The default is 0.

Primary stabilization time
The stabilization time for the primary interface. The default is 1.

start-time-of-day-revert-back
The earliest time of the day the router can switch back to the primary route. The router can revert back to the primary any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary will only occur if the primary is up and the stabilization parameters are met. The default is 0.

Example:

```
WRS Config>set start
Primary interface number  [0]? 1
Time-of-Day revert back window start (1 - 24 hours, 0 = not configured) [0] 3
Start time-of-day revert back configured. Remember to configure stop time-of-day
```

Primary interface number
This is the primary interface number of the primary interface for which you are setting first-stabilization. The default is 0.

Time-of-day-revert-back-window start
This time marks the beginning time for the revert back window. The router can revert back to the primary interface any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary interface will only occur if the primary interface is up and the stabilization parameters are met. The default is 1.

stop-time-of-day-revert-back
This time marks the ending time for the revert back window. The router can revert back to the primary interface any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary interface will only occur if the primary interface is up and the stabilization parameters are met. The default is 1.

Example:

```
WRS Config>set stop
Primary interface number  [0]? 1
Time-of-Day revert back window stop (1 - 24 hours, 0 = not configured) [0]?5
```

Primary interface number
This is the primary interface number of the primary interface for which you are setting first-stabilization. The default is 0.

Time-of-day-revert-back-window stop
This time marks the ending time for the revert back window. The router can revert back to the primary interface any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary interface will only occur if the primary interface is up and the stabilization parameters are met. The default is 1.

Accessing the WAN Restoral Interface Monitoring Process

To access the WAN Restoral interface monitoring process, enter the following command at the GWCON (+) prompt:

```
+ feature wrs
```

WAN Restoral Monitoring Commands

The WAN Restoral (WRS) monitoring commands allow you to monitor the state of WAN Restoral primary-secondary pairs, WAN Reroute primary-alternate pairs, and Dial-on-Overflow. Any modifications to the operational state of WAN Restoral, WAN Reroute, and Dial-on-Overflow made through the monitoring interface are not maintained across router restarts.

Access the WRS prompt by entering **feature wrs** at the GWCON (+) prompt. Table 9 lists the WRS commands and their functions, and the following sections explain the commands.

Table 9. WAN Restoral 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 xxvi.
Clear	Clears the monitoring statistics displayed using the **list** command.
Disable	Disables the WRS, or an individual secondary, or alternate, or dial-on-overflow.
Enable	Enables the WRS, or an individual secondary, or alternate, or dial-on-overflow.
List	Displays the monitoring information on one or all alternate or secondary circuits.
Set	Sets the values for the stabilization and time-of-day-revert-back-timers.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Clear

Use the **clear** command to clear WAN Restoral, WAN Reroute, and dial-on-overflow statistics that are displayed using the **list** command.

Syntax:

clear

Note: This command clears *Longest restoral period*, but does not clear the *Most recent restoral period*. For the screen display, refer to the example in the **list** command.

Disable

Use the **disable** command to disable the WAN Restoral feature completely, disable the restoral of a particular primary interface by its associated secondary interface, disable an alternate interface or disable dial-on-overflow.

Syntax:

disable alternate-circuit
dial-on-overflow
secondary-circuit
wrs

alternate-circuit
Disables a primary/alternate pairing for WAN Reroute. There can be multiple pairings using the same alternate. This command disables all the pairings using the specified alternate-circuit.

Example:

```
WRS>disable alternate-circuit
Alternate circuit number  [0]? 6
```

Alternate circuit number
This is the number of the alternate circuit. The default is 0.

dial-on-overflow
Disables dial-on-overflow for the specified primary/alternate pairing, without changing the enabled/disabled state of WAN Reroute for that pairing. If dial-on-overflow is actively routing, it is terminated at the expiration of the next monitor interval.

secondary-circuit
Disables the restoral of a particular primary interface by its associated secondary interface until the next **restart**, **reload**, or **enable secondary-circuit** command. Both interfaces must have been previously configured and bound together in the WRS configuration.

Normally, in **talk 5** (GWCON), the **disable** command causes the interface to be inactive and stay inactive. For WAN Restoral secondary, however, this is not the case. The **disable** command applied to the secondary interface does not disable the interface itself. It disables only the current call (that is, causes any active call to be disconnected.) To disable use of the secondary circuit, you need to **disable secondary-circuit** at the WAN Restoral monitoring prompt and disable the secondary interface at the top level GWCON prompt.**Example:**

```
WRS>disable secondary-circuit
Secondary interface number  [0]? 3
```

Secondary interface number
This is the number of the secondary interface previously configured with the **add secondary-circuit** command. The default is 0.

wrs Disabling WRS disables WAN Restoral, WAN Reroute, and Dial-on-overflow on the router until the next **restart**, **reload**, or **enable WRS** command.

Enable

Use the **enable** command to enable the WAN Restoral interface, enable the restoral of a primary link by a secondary circuit, enable an alternate circuit, or enable dial-on-overflow.

Syntax:

enable alternate-circuit
dial-on-overflow
secondary-circuit
wrs

alternate-circuit
Enables the primary/alternate pairings for WAN Reroute for all pairings using the specified alternate.

Example:

```
WRS> enable alternate-circuit
Alternate circuit number  [0]? 3
```

Alternate circuit number
This is the interface number of the alternate circuit. The default is 0.

dial-on-overflow
Enables dial-on-overflow and allows you to set parameters that control dial-on-overflow. Optionally, allows you to cause the IP protocol to be switched immediately to the alternate, as if the add threshold had been crossed.

Example:

```
WRS> dial-on-overflow

For dial-on-overflow, only IP traffic can overflow to the alternate interface.
Primary interface number  [0]? 1
add-threshold (1-100% utilization) [90]?
drop-threshold(0-99% utilization) [60]?
bandwidth test interval(10-200 seconds) [15]?
minimum time to keep the alternate up (20-21600 sec.) [300]?
Dial-on overflow is enabled.
Remember to configure the primary interface's line speed!

Do you want to switch IP traffic to the alternate now?(Yes or [No]):
WRS>
```

secondary-circuit
Enables the restoral of a primary link by the indicated secondary link.

Example:

```
WRS> enable secondary-circuit
Secondary interface number  [0]? 3
```

Secondary interface number
This is the number of the secondary interface previously configured with the **add secondary-circuit** command. The default is 0.

wrs Enables the function of the WAN Restoral feature on the router. This feature needs to be enabled in order to do WAN Restoral, WAN Reroute, or Dial-on-overflow.

Set

Use the **set** command to set the parameters for WAN Reroute.

Syntax:

set ?

default

first-stabilization

stabilization

start-time-of-day-revert-back

stop-time-of-day-revert-back

default
Use the **set default** command to set the defaults to be used by links that do not have configured stabilization and first-stabilization times.

Example:

```
WRS Config>set default ?
FIRST-STABILIZATION
STABILIZATION
```

first-stabilization

Sets the default first-stabilization value to be used for links for which a first-stabilization time was not configured.

```
WRS Config>set default first

Default first primary stabilization time (0 - 3600 seconds)  [0]? 20
```

stabilization

Sets the default stabilization value to be used for links for which a stabilization time was not configured.

```
WRS Config>set default stab
Default primary stabilization time (0 - 3600 seconds)  [0]? 30
```

first-stabilization

Sets the number of seconds at router initialization before routing for this primary link is switched to the alternate link if the primary link is not up.

Example:

```
WRS Config>set first
Primary interface number  [0]? 1
First primary stabilization time (0 - 3600 seconds -1 = default)  [-1]?
```

Primary interface number

This is the primary interface number of the primary interface for which you are setting first-stabilization. The default is 0.

First primary stabilization time

The stabilization time for this primary interface. The default is 1.

stabilization

Sets the number of seconds required after the primary link is first detected to be up before routing is switched back to the primary. Routing over the alternate link continues until the primary link remains up for this number of seconds.

Example:

```
WRS Config>set first
Primary interface number  [0]? 1
Primary stabilization time (0 - 3600 seconds -1 = default)  [-1]?
```

Primary interface number

This is the primary interface number of the primary interface for which you are setting stabilization. The default is 0.

Primary stabilization time

The stabilization time for the primary interface. The default is 1.

start-time-of-day-revert-back

The earliest time of the day the router can switch back to the primary route. The router can revert back to the primary any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary will only occur if the primary is up and the stabilization parameters are met. The default is 0.

Example:

```
WRS Config>set start
Primary interface number [0]? 1
Time-of-Day revert back window start (1 - 24 hours, 0 = not configured) [0] 3
Start time-of-day revert back configured. Remember to configure stop time-of-day
```

Primary interface number

This is the primary interface number of the primary interface for which you are setting first-stabilization. The default is 0.

Time-of-day-revert-back-window start

This time marks the beginning time for the revert back window. The

router can revert back to the primary interface any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary interface will only occur if the primary interface is up and the stabilization parameters are met. The default is 1.

stop-time-of-day-revert-back

This time marks the ending time for the revert back window. The router can revert back to the primary interface any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary interface will only occur if the primary interface is up and the stabilization parameters are met. The default is 1.

Example:

```
WRS Config>set stop
Primary interface number  [0]? 1
Time-of-Day revert back window start (1 - 24 hours, 0 = not configured) [0]?
5
```

Primary interface number

This is the primary interface number of the primary interface for which you are setting first-stabilization. The default is 0.

Time-of-day-revert-back-window stop

This time marks the ending time for the revert back window. The router can revert back to the primary interface any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary interface will only occur if the primary interface is up and the stabilization parameters are met. The default is 1.

List

Use the **list** command to display monitoring information on one or all WAN Restoral primary-secondary pairs or one or all WAN Reroute primary-alternate pairs.

Syntax:

list all | alternate-circuit | secondary-circuit | summary

all Provides summary information, followed by the specific information, for each secondary interface.

Example:

```
list all
WAN Restoral/Re-route is enabled with 2 circuits configured
    Total restoral attempts =          7 completions   =          7
    Total packets forwarded =         39
    Longest completed restoral period in hrs:min:sec     0:03:27

    Total overflow attempts =         20 completions   =         19
    Longest completed overflow period in hrs:min:sec     0:05:00

   Primary       Secondary    Restoral  Restoral   Current/Longest
Net Interface  Net Interface  Enabled    Active       Duration
-------------  -------------  --------  --------   --------------------
  4  PPP/0       7  PPP/1       No         No       00:03:27/ 00.06.00

                              Re-route/ Re-route/         Recent
   Primary       Alternate    Overflow  Overflow     Reroute/Overflow
```

```
Net Interface  Net Interface  Enabled    Active          Duration
-------------  -------------  --------  --------   --------------------
  1   FR/0       2   FR/1     Yes/Yes    No /No     00:00:56/ 00:05:00
```

Total restoral attempts
The number of times the primary link failed, causing the router to try to bring up a secondary link.

Completions
The number of successful restoral attempts when the secondary link came up and was used.

Total packets forwarded
The total number of packets forwarded across the secondary interface. It is the sum of both directions, and is cumulative over all successful restores, until the restart or clear restoral-statistics command is issued.

Longest Completed Restoral Period
This field displays in hours, minutes, and seconds the longest amount of time a restoral was in operation, not counting any current usage.

Total Overflow Attempts
The number of attempts due to an overflow.

Completions
The number of successful overflow attempts when the secondary link came up and was used.

Longest Completed Overflow Period
Displays in hours, minutes , and seconds the longest amount of time an overflow was in operation, not counting any current usage.

Primary Net Interface
The interface that is being backed up by its associated secondary interface.

Secondary Net Interface
The dial circuit that is being used to back up the associated primary interface.

Restoral Enabled
Indicates that restoral of this primary interface is currently enabled.

Restoral Active
Indicates whether restoral is active (Yes or No).

Current/Longest Duration
Indicates in hours, minutes, and seconds the current and longest duration the secondary net interface was up.

Primary Net Interface
The interface that is being backed up by its associated alternate interface.

Alternate Net Interface
The interface that is being used as an alternate back up the associated primary interface.

Re-route/Overflow Enabled
Indicates whether reroute and overflow are enabled (Yes or No).

Re-route/Overflow Active
Indicates whether reroute and overflow are active (Yes or No).

Recent Re-route Overflow Duration
Indicates in hours, minutes, and seconds the recent reroute and overflow duration of the alternate net interface.

Alternate-circuit
Provides totals for an alternate circuit. Allows the monitoring operator to retrieve the WAN Reroute state and associated statistics for each alternate interface and its associated primary mapping.

Example:

```
WRS>li alt 7
Primary    1:FR/0 Frame Relay V.35/V.36
Alternate  7:PPP/1 Point to Point V.25bis Dial Circuit
reroute Enabled, currently inactive
overflow Enabled, currently inactive
Primary first stabilization time: default (0 seconds)
Primary stabilization time: default (0 seconds)
Time-of-day revert back not configured: start = 0, stop = 0
Restored 0 times (0 attempts)
Overflow 0 times (0 attempts)
```

Primary Interface
The interface that is being backed up by this associated alternate interface.

Alternate Interface
The dial circuit that is being used to back up the associated primary interface.

Reroute Enabled
Indicates whether reroute of this primary interface is currently enabled.

Overflow Enabled
Indicates whether overflow of this primary interface is currently enabled.

Primary first stabilization
The number of seconds at router initialization before routing for this primary link is switched to the alternate link if the primary link is not up.

First stabilization
The number of seconds required after the primary link is first detected to be up before routing is switched back to the primary. Routing over the alternate link continues until the primary link remains up for this number of seconds.

Time-of-day revert back
The time of the day the router can switch back to the primary route. The router can revert back to the primary any time between the start-time-of-day-revert-back time and the stop-time-of-day-revert-back time. Reverting back to the primary will only occur if the primary is up and the stabilization parameters are met. The default is 0.

Restored times
The number of attempts to reroute the primary interface.

Overflow times
The number of dial-on-overflow attempts.

secondary-circuit
Provides totals for each secondary circuit. Allows the monitoring operator to

retrieve the WAN Restoral state and associated statistics for each secondary interface and its associated primary mapping.

Example:

```
list secondary-circuit
Secondary interface number  [0]? 1

                                                    Secondary
Primary Interface          Secondary Interface      Enabled
-------------------        -------------------      ---------
1  PPP/0  Point to Poi     3  PPP/1  Point to Poi     Yes

Router primary interface state = Up
Router secondary interface state = Available
Restoral Statistics:

  Primary restoral attempts =       6   completions =    5
  Restoral packets forwarded =    346
    Most recent restoral period in hrs:min:sec          00:08:20
```

Primary Interface
The interface that is being backed up by this associated secondary interface.

Secondary Interface
The dial circuit that is being used to back up the associated primary interface.

Secondary Enabled
Indicates whether restoral of this primary interface is currently enabled.

Router Primary Interface State
Indicates that the primary interface state is one of the following:

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 link is configured but there is a hardware problem.

Router Secondary Interface State
Indicates that the associated secondary interface state is one of the following:

Up - Indicates that the link is up.

Down - Indicates that the link is down. This also occurs when the base network for the secondary is disabled either at the `Config>` prompt or at the operator console.

Available - Indicates that the link is in the waiting mode.

Testing - Indicates that the link is in the process of establishing a connection.

Restoral Statistics:

Primary Restoral Attempts
The number of times the primary failed, causing the router to try to bring up a secondary link.

Restoral Packets forwarded
This field indicates the total number of packets forwarded.

Most Recent Restoral Period
This indicates how long the secondary was up, the last time it was used or during the current restoral use.

Configuring WAN Restoral

summary

Provides totals for each secondary circuit.

Example:

```
list summary
WAN Restoral is enabled with 3 circuit(s) configured

  Total restoral attempts =      3 completions =      2
  Total packets forwarded =    346
  Longest restoral period in hrs:min:sec   00:08:20

Primary Interface and State      Secondary Interface and State
---------------------------   ----------------------------------
 1  PPP/0  - Up                 3  PPP/1  - Available
```

Total restoral attempts

The number of times the primary failed, causing the router to try to bring up a secondary link.

Completions

The number of successful restoral attempts when the secondary came up and was used.

Total packets forwarded

The total number of packets forwarded across the secondary interface. It is the sum of both directions, and is cumulative over all restoral periods until the restart or clear restoral-statistics command is used.

Longest restoral period

This field displays in hours, minutes, seconds the longest amount of time restoral was in use, not counting the current usage.

Primary Interface and State

The interface that is being backed up by its associated secondary. Valid states are:

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 link is configured but there is a hardware problem.

Secondary Interface and State

The dial circuit that is being used to back up the associated primary. Valid states are:

Up - Indicates that the link is up.

Down - Indicates that the link is down. This also occurs when the base network for the secondary is disabled either at the `Config>` prompt or at the operator console.

Testing - Indicates that the link is in the process of establishing a connection.

Available - Indicates that the link is in the waiting mode.

Chapter 7. The WAN Reroute Feature

This chapter describes the WAN reroute feature. It includes the following sections:

WAN Reroute Overview

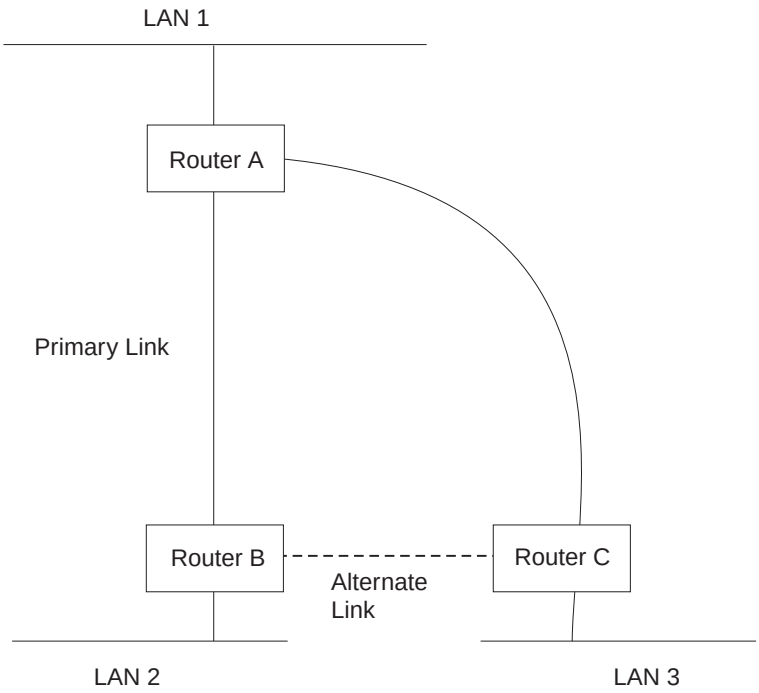
WAN Reroute lets you set up an alternate route so that if a primary link fails, the router automatically initiates a new connection to the destination through the alternate route. See "Overview for WAN Restoral, WAN Reroute, and Dial-on-Overflow" on page 61 for an explanation of WAN Restoral, and how WAN Reroute and Dial-on-overflow work together.

The WAN Reroute process involves:

1. Detecting the primary link failure
2. Switching to the alternate link
3. Detecting the primary link recovery
4. Switching back to the primary link

The alternate link can be any link on which you can configure routable protocols (for example, IP, IPX) and the datalink type of the alternate link need not match the datalink type of the primary link. For example, the alternate link can be a LAN interface, a PPP, Frame Relay, or X.25 serial interface, or a PPP or Frame Relay dial circuit. The following are examples of interface types that cannot be alternate links: SDLC serial interfaces, SRLY serial interfaces, and base nets like V.25bis and ISDN.

Note: If the primary link or alternate link is a dial circuit, that dial circuit cannot be configured for dial-on-demand.



If the primary link between routers A and B fails, WAN reroute establishes an alternate link between routers B and C. Routers A and B can then communicate through router C.

Figure 3. WAN Reroute. Normally, there is a connection between Routers A and B and Routers A and C.

Dial-on-Overflow

Dial-on-overflow allows you to use an alternate interface for IP traffic when the traffic rate on the primary link reaches a specified threshold. This means that the primary interface does not have to be down before the alternate link is brought up. When the primary interface's traffic reaches the specified threshold the router brings up the alternate link. To use dial-on-overflow, WAN Reroute must be configured and the primary interface must be Frame Relay. IP is the only protocol that can be switched over to the alternate interface by dial-on-overflow. Also, OSPF should be used as the IP routing protocol instead of RIP when dial-on-overflow is used.

For information about configuring dial-on-overflow, see "WAN Restoral, WAN Reroute, and Dial-on-Overflow Configuration Commands" on page 65.

Bandwidth Monitoring

The interval for bandwidth monitoring can be specified for dial-on-overflow during WAN Reroute configuration. The primary interface's receive and transmit bandwidth utilization are monitored. When the primary interface's bandwidth reaches the *add* threshold, a WAN Reroute request is generated to bring up the alternate interface. If WAN Reroute is successful bringing up the alternate interface, IP stops routing over the primary interface and starts routing over the alternate interface.

If WAN Reroute is not successful in bringing up the alternate route it periodically attempts to bring up the alternate interface until the primary interface's bandwidth utilization drops below the *drop* threshold.

When the primary interface's receive and transmit bandwidth utilization reaches the *drop* threshold and the minimum configured up time has expired the alternate interface is dropped. This causes IP to stop routing over the alternate interface and start using the primary interface.

The add-threshold and the drop-threshold are specified as a percentage of the configured line speed for the primary link. The configured line speed does not always match the actual speed of the link. The amount of traffic on the link in each direction is calculated separately. The threshold is exceeded if the traffic in either direction is greater then the specified percentage.

Configuring WAN Reroute

Following are the steps required to configure WAN reroute. The next section shows an example of how to perform these tasks.

To configure WAN Reroute, you need to:

1. Configure the primary link.
2. Configure the alternate link.
3. Assign the alternate link to the primary link. You can also specify a stabilization period for the primary link.

   You can specify a time-of-day revert-back to the primary link which will happen after the stabilization period is over (if configured). This allows the secondary to stay up until such time that the user desires and revert back to the primary during off-peak hours.

   Note: The primary and alternate links can be different datalink types. The primary and alternate links can be:
   - A LAN interface.
   - A PPP serial interface.
   - A Frame Relay serial interface.
   - An X.25 serial interface.
   - A PPP dial circuit.
   - A Frame Relay dial circuit.

Sample WAN Reroute Configuration

Figure 4 on page 84 shows WAN reroute using a Frame Relay dial circuit over ISDN as the alternate link. If the Frame Relay DLCI between router A and router C fails, WAN reroute uses the dial circuit to establish an alternate connection through router D. If one of the primary links from a branch to headquarters fails, WAN reroute establishes an alternate route to headquarters through another branch.

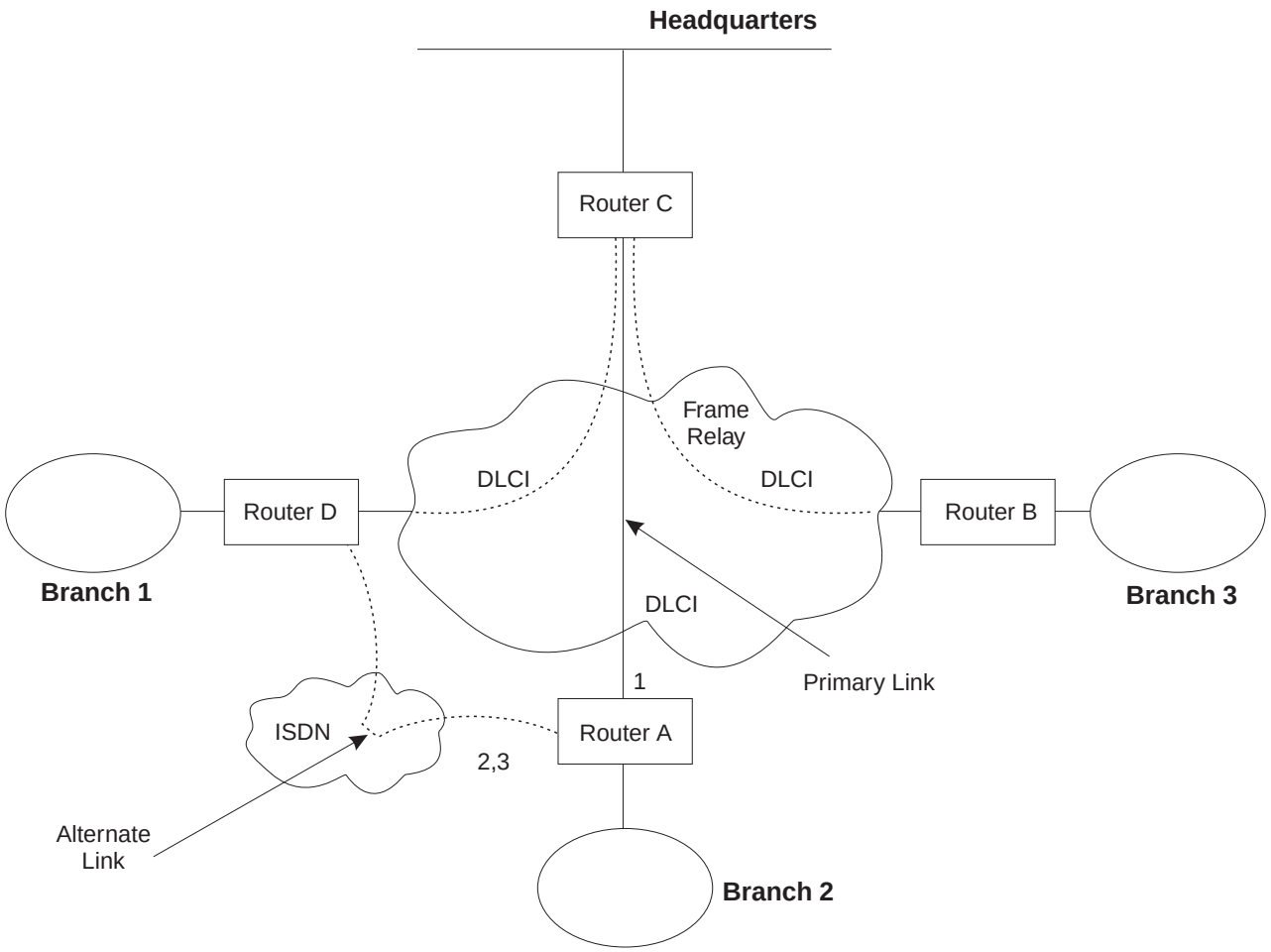


Figure 4. Sample WAN Reroute Configuration. Branch offices use frame relay to connect to headquarters.

The following sections describe how to set up WAN reroute on Router A in Figure 4. You will need to:

- Configure the primary frame relay interface (1) to have a Required PVC or Required PVC Group or enable the No-PVC feature on the frame relay interface.
- Configure the ISDN interface (2) and its frame relay dial circuit (3).
- Assign the dial circuit to be the alternate link for the primary frame relay interface and issue the 'set idle 0' command at the dial circuit config prompt.
  - Optionally, you can assign:
  - Stabilization period for the primary link,
  - Time-of-day revert-back window for the primary link.

These tasks are described in detail below.

Configuring the Frame Relay Interface

To configure the frame relay interface for WAN reroute, on Router A, add a PVC between Routers A and C on the primary Frame Relay interface.

To cause the primary FR interface to declare itself down when the connection to other router(s) is lost, you have three options:

1. Enable the No-PVC feature. When this feature is enabled, the FR interface goes down when there are no active PVCs.
2. Configure a PVC as required but don't include the PVC in a required PVC group. In this case, the FR interface goes down when the PVC becomes inactive.
3. Configure a set of PVCs as required and as part of a required PVC group. In this case, the FR interface goes down when all of the PVCs of a required PVC group become inactive.

Follow these steps to configure the primary frame relay interface:

1. If you have not yet done so, set the data link on the interface to frame relay.

```
Config>set data-link frame relay
Interface Number [0]? 2
```

2. Enter the Frame Relay configuration process.

```
Config>network
What is the network number [0]?2
Frame Relay user configuration
FR Config>
```

Note: Complete only *one* of the two remaining steps for configuring the primary frame relay interface.

3. Add a PVC using the **add permanent-virtual-circuit** command.

   To configure the PVC as Required:

   Enter **y** to the question "Is circuit required for interface operation ?".

   To configure the PVC as a member of a required PVC group:

   a. Enter **y** to the question "Does circuit belong to a Required PVC group ?".
   b. Enter a group name in response to the question "What is the group name ?".

   If you have already added PVCs, use the **change permanent-virtual-circuit** command to configure the PVC as Required and to assign it to a Required PVC Group, as appropriate. Refer to Using Frame Relay Interfaces in *Access Integration Services Software User's Guide* for more information.

```
FR Config>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]?
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
```

4. If desired, enable the No-PVC feature.

Note: Complete this step *only* if you bypassed the previous step.

```
FR Config>enable no-pvc
```

There are additional parameters that you can set for frame relay. For more information, see 'Using Frame Relay' in *Access Integration Services Software User's Guide*.

Configuring the ISDN Interface and Dial Circuit

Configure the ISDN interface and dial circuit between Router A and Router D. See 'Using the ISDN Interface' in *Access Integration Services Software User's Guide* for information on how to configure ISDN interfaces and dial circuits.

Unlike WAN Restoral, you must configure routable protocols on the dial circuit that will be used as the alternate link. If those routable protocols cannot be prevented from sending maintenance packets, the alternate link will establish a connection even if rerouting is not necessary. In this case if you want to use the alternate link only for rerouting, disable the dial circuit. To disable the dial circuit, enter the **disable interface** command at the `Config>` prompt.

If you have multiple dial circuits assigned to the ISDN interface, you can set a priority for the dial circuits. If all the B channels have active dial circuits on the physical interface and a circuit with a higher priority receives a packet, the lowest priority connection is terminated and the high priority circuit establishes a connection.

You can set the priority to between 0 and 15, where 15 is the highest priority circuit and 0 is the lowest priority circuit. The default priority for new dial circuits is 8. Enter **set priority** at the `Circuit Config>` prompt to change the priority.

Assigning and Configuring the Alternate Link

Enter the WAN reroute configuration process to assign the dial circuit as the alternate link for a LAN interface, a PPP, Frame Relay, or X.25 serial interface, or a PPP or Frame Relay dial circuit, and if desired, to specify the stabilization periods and/or the time-of-day revert-back window.

There are two types of stabilization periods:

- *First stabilization period* is the amount of time the router waits for the primary interface to become active when the router first attempts to bring it up. If, after the first stabilization period, the primary has not come up, WAN reroute brings up the alternate link.
- *Stabilization period* is the amount of time the router waits to be sure the primary link is reliable before it switches from the alternate link back to the primary link.

The time-of-day revert-back window is the specific time of day when the user desires the switch back to the primary after it is up and any configured stability time has passed.

Using a 24-hour clock, the user specifies the start and stop hours of the revert back window. The secondary stays up and is not taken down until the start hour is reached. If the time of day when the primary comes up is between the start and stop hours (in the window) then the switch to the primary link is immediate after the stability time is up.

Follow these steps to assign and configure the alternate link:

1. Enter the WAN Restoral configuration process.

```
Config>feature wrs
WAN Restoral user configuration
```

2. Assign the dial circuit as the alternate link for the primary frame relay interface.

```
WRS Config>add alternate-circuit
Alternate interface number  [0]? 4
Primary interface number  [0]? 1
```

3. Enable the alternate circuit.

```
WRS Config>enable alternate-circuit
Alternate interface number  [0]? 4
```

4. Optionally, specify a first stabilization period.

To set the first stabilization period for a specific primary interface, use the **set first-stabilization-period** command. To set a default first stabilization period for all interfaces that do not have specific periods set, use the **set default first-stabilization-period** command.

```
WRS Config>set first-stabilization-period
Primary interface number [0]?
First primary stabilization time (0 - 3600 seconds -1=default) [-1]?

WRS Config>set default first-stabilization-period
Default first primary stabilization time (0 - 3600 seconds) [0]?
```

5. Optionally, specify a stabilization period. To set a stabilization period for specific interfaces use the **set stabilization-period** command. To set a default stabilization period for all interfaces that do not have specific periods set, use the **set default stabilization-period** command.

```
WRS Config>set stabilization-period
Primary interface number [0]?
First primary stabilization time (0 - 3600 seconds -1=default) [-1]?
WRS Config>set default stabilization-period
Default first primary stabilization time (0 - 3600 seconds) [0]?
```

6. Optionally, specify a time-of-day revert-back window.

   To set the start and stop times for specific interface windows use the set start-time-of-day-revert-back and stop-time-of-day-revert-back commands. The default value of zero means no window is configured. The 24-hour clock starts at 1 a.m. and ends at 24 midnight. If the start and stop times are the same (but not zero) then the revert back will happen at exactly that hour.

   Following are two examples of setting the revert-back window:

   a. A start time of 23 and a stop time of 3 will give a revert-back window from 11 p.m. until 3 a.m.

   b. A start time of 1 and a stop time of 5 will give a revert-back window from 1 a.m. to 5 a.m.

```
WRS Config> set start-time-of-day-revert-back
Primary interface number [0]?
Time-of-Day revert back window start (1 - 24 hours, 0 = not configured) [0]?
WRS Config> set stop-time-of-day-revert-back
Primary interface number [0]?
Time-of-Day revert back window stop (1 - 24 hours, 0 = not configured) [0]?
```

Configuring WAN Reroute

Chapter 8. Using the Network Dispatcher Feature

This chapter describes how to use the Network Dispatcher Feature and contains the following sections:

Network Dispatcher uses load-balancing technology from IBM Research Division to determine the most appropriate server to receive each new connection. This is the same technology used in IBM's Network Dispatcher product for Solaris, Windows NT and AIX.

Overview of Network Dispatcher

Network Dispatcher is a feature that boosts the performance of servers by forwarding TCP/IP session requests to different servers within a group of servers, thus load balancing the requests among all servers. The forwarding is transparent to the users and to applications. Network Dispatcher is useful for server applications such as e-mail, World Wide Web servers, distributed parallel database queries, and other TCP/IP applications.

Network Dispatcher can also be used for load balancing stateless UDP application traffic to a group of servers.

Network Dispatcher can help maximize the potential of your site by providing a powerful, flexible, and scalable solution to peak-demand problems. During peak demand periods, Network Dispatcher can automatically find the optimal server to handle incoming requests.

The Network Dispatcher function does not use a domain name server for load balancing. It balances traffic among your servers through a unique combination of load balancing and management software. Network Dispatcher can also detect a failed server and forward traffic to other available servers.

All client requests sent to the Network Dispatcher machine are forwarded to the server that is selected by the Network Dispatcher as the optimal server according to certain dynamically set weights. You can use the default values for those weights or change the values during the configuration process.

The server sends a response back to the client without any involvement of Network Dispatcher. No additional software is required on your servers to communicate with Network Dispatcher.

The Network Dispatcher function is the key to stable, efficient management of a large, scalable network of servers. With Network Dispatcher, you can link many individual servers into what appears to be a single, virtual server. Your site thus

appears as a single IP address to the world. Network Dispatcher functions independently of a domain name server; all requests are sent to the IP address of the Network Dispatcher machine.

Network Dispatcher allows a management application that is SNMP-based to monitor Network Dispatcher status by receiving basic statistics and potential alert situations. Refer to “SNMP Management” in the *Protocol Configuration and Monitoring Reference Volume 1* for more information.

Network Dispatcher brings distinct advantages in load balancing traffic to clustered servers, resulting in stable and efficient management of your site.

Balancing TCP and UDP Traffic Using Network Dispatcher

There are many different approaches to load balancing. Some of these approaches allow users to choose a different server at random if the first server is slow or not responding. Another approach is round-robin, in which the domain name server selects a server to handle requests. This approach is better, but does not take into consideration the current load on the target server or even whether the target server is available.

Network Dispatcher can load balance requests to different servers based on the type of request, an analysis of the load on servers, or a configurable set of weights that you assign. To manage each different type of balancing, the Network Dispatcher has the following components:

Executor

Load balances connections based on the type of request received. Typical request types are HTTP, FTP, and Telnet. This component always runs.

Advisors

Queries the servers and analyzes the results by protocol for each server. The advisor passes this information to the ***manager*** to set the appropriate weight. The advisor is an optional component.

Network Dispatcher supports advisors for FTP, HTTP, SMTP, NNTP, POP3, and Telnet as well as a TN3270 advisor that works with TN3270 servers in IBM 2210s, IBM 2212s, and IBM 2216s and an MVS advisor that works with Workload Manager (WLM) on MVS systems. WLM manages the amount of workload on an individual MVS ID. Network Dispatcher can use WLM to help load balance requests to MVS servers running OS/390 V1R3 or later release.

There are no protocol advisors specifically for UDP protocols. If you have MVS servers, you can use the MVS system advisor to provide server load information. Also, if the port is handling TCP and UDP traffic, the appropriate TCP protocol advisor can be used to provide advisor input for the port. Network Dispatcher will use this input in load balancing both TCP and UDP traffic on that port.

Manager

Sets weights for a server based on:

- Internal counters in the executor
- Feedback from the servers provided by the protocol advisors
- Feedback from a system monitor (MVS advisor).

The manager is an optional component. However, if you do not use the manager, the Network Dispatcher will balance the load using a round-robin scheduling method based on the current server weights.

When using Network Dispatcher to load balance stateless UDP traffic, you must only use servers that respond to the client using the destination IP address from the request. See “Configuring a Server for Network Dispatcher” on page 97 for a more complete explanation.

High Availability for Network Dispatcher

The base Network Dispatcher function has the following characteristics that makes it a single point of failure from many different perspectives:

- It examines all the traffic on the way in. If some of the packets for an existing connection use a different path through a different Network Dispatcher to reach a server, the server immediately resets the connection.
- It keeps track of all established connections and although it does not terminate them, entries lost from the Network Dispatcher connection table will result in the resetting of a connection.
- It appears to any previous hop router as the last hop, and the connection’s termination.

All these characteristics make the following failures critical for the whole cluster:

- If the Network Dispatcher fails for any reason, all the connection tables are lost, therefore all existing connections from the client to the server are also lost. Assuming there is a second Network Dispatcher that can direct a client to the servers, new connections will be able to go through only after the usual routing protocol delays which could be several minutes.
- If the configured Network Dispatcher interface to the previous IP router fails, there must either be another interface to get to the same Network Dispatcher, in which case recovery is performed by the IP router (using the ARP aging mechanism with delays in the order of several minutes), or all connections will be lost.
- If Network Dispatcher interface to the servers fails, the previous hop router assumes that the Network Dispatcher is the last hop, and therefore will not reroute new connections. Existing connections will be lost and new connections will not be established.

In all these failure cases, which are not only Network Dispatcher failures but also Network Dispatcher neighborhood failures, all the existing connections are lost. Even with a backup Network Dispatcher running standard IP recovery mechanisms, recovery is, at best, slow and applies only to new connections. In the worst case, there is no recovery of the connections.

To improve Network Dispatcher availability, the Network Dispatcher High Availability function uses the following mechanisms:

- Two Network Dispatchers with connectivity to the same clients, and the same cluster of servers, as well as connectivity between the Network Dispatchers.
- A “Heartbeat” mechanism between the two Network Dispatchers to detect Network Dispatcher failure.
- A reachability criteria, to identify which IP host can and cannot be reached from each Network Dispatcher.

- Synchronization of the Network Dispatcher databases (that is, the connection tables, reachability tables, and other databases).
- Logic to elect the active Network Dispatcher, which is in charge of a given cluster of servers, and the standby Network Dispatcher, which continuously gets synchronized for that cluster of servers.
- A mechanism to perform fast IP takeover, when the logic or an operator decides to switch active and standby.

Failure Detection

Besides the basic criteria of failure detection, (the loss of connectivity between active and standby Network Dispatchers, detected through the Heartbeat messages) there is another failure detection mechanism named “reachability criteria.” When you configure the Network Dispatcher, you provide a list of hosts that each of the Network Dispatchers should be able to reach to work correctly. The hosts could be routers, IP servers or other types of hosts. Host reachability is obtained by pinging the host.

Switchover takes place either if the Heartbeat messages cannot go through, or if the reachability criteria are no longer met by the active Network Dispatcher and the standby Network Dispatcher is reachable. To make the decision based on all available information, the active Network Dispatcher regularly sends the standby Network Dispatcher its reachability capabilities. The standby Network Dispatcher then compares the capabilities with its own and decides whether to switch.

Database Synchronization

The primary and backup Network Dispatchers keep their databases synchronized through the ″Heartbeat″ mechanism. The Network Dispatcher database includes connection tables, reachability tables and other information. The Network Dispatcher High Availability function uses a database synchronization protocol that insures that both Network Dispatchers contain the same connection table entries. This synchronization takes into account a known error margin for transmission delays. The protocol performs an initial synchronization of databases and then maintains database synchronization through periodic updates.

Recovery Strategy

In the case of a Network Dispatcher failure, the IP takeover mechanism will promptly direct all traffic toward the standby Network Dispatcher. The Database Synchronization mechanism insures that the standby has the same entries as the active Network Dispatcher. When the failure occurs in the network (any intermediate piece of hardware or software between the client and the back-end server), and there is an alternate path through the standby Network Dispatcher that works, the switchover is performed across the alternate path.

IP Takeover

Note: Cluster IP Addresses are assumed to be on the same logical subnet as the previous hop router (IP router).

The IP Router will resolve the cluster address through the ARP protocol. To perform the IP takeover, the Network Dispatcher (standby becoming active) will issue an ARP request to itself, that is broadcasted to all directly attached networks belonging

to the logical subnet of the cluster. The previous hops' IP router will update their ARP tables (according to RFC826) to send all traffic for that cluster to the new active (previously standby) Network Dispatcher.

Configuring Network Dispatcher

There are many ways that you can configure Network Dispatcher to support your site. If you have only one host name for your site to which all of your customers will connect, you can define a single cluster and any ports to which you want to receive connections. This configuration is shown in Figure 5.

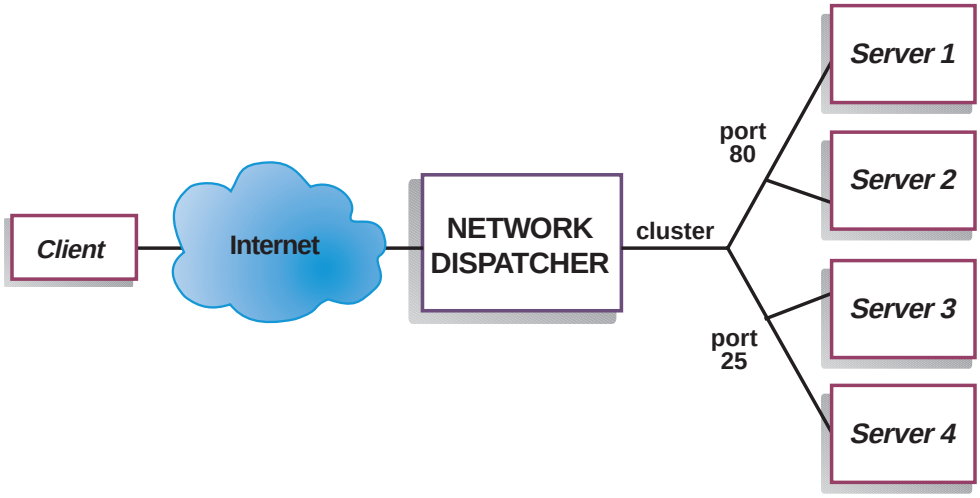


Figure 5. Example of Network Dispatcher Configured With a Single Cluster and 2 Ports

Another way of configuring Network Dispatcher would be necessary if your site does content hosting for several companies or departments, each one coming into your site with a different URL. In this case, you might want to define a cluster for each company or department and any ports to which you want to receive connections at that URL as shown in Figure 6 on page 94.

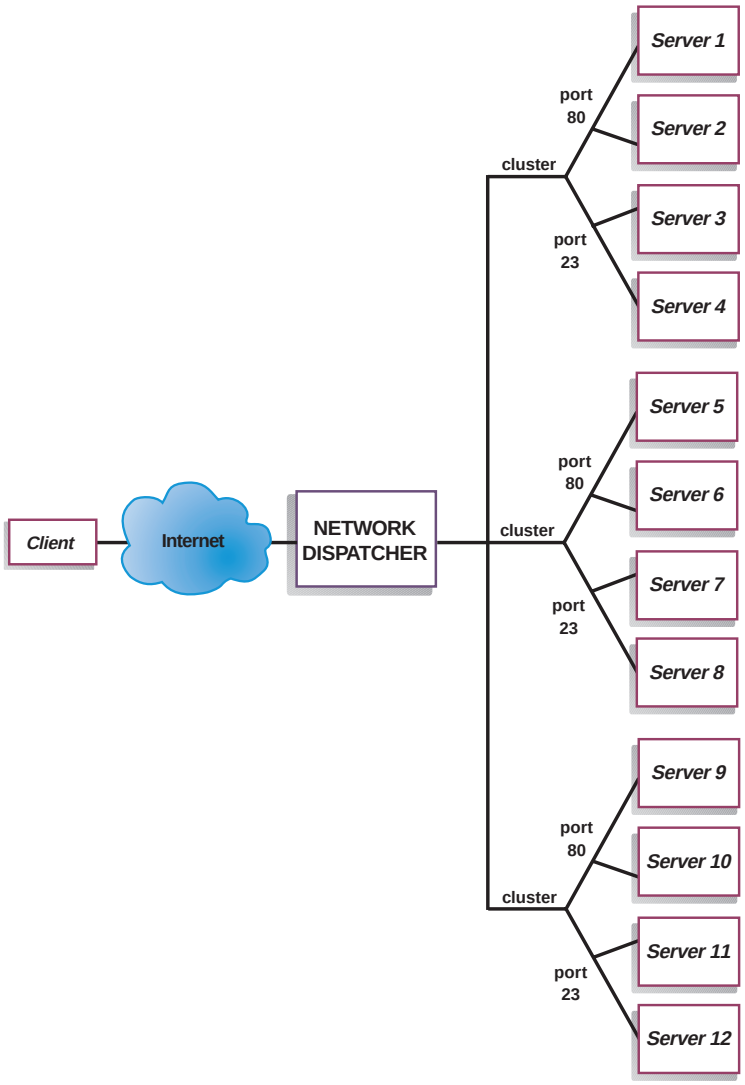


Figure 6. Example of Network Dispatcher Configured With 3 Clusters and 3 URLs

A third way of configuring Network Dispatcher would be appropriate if you have a very large site with many servers dedicated to each protocol supported. For example, you may choose to have separate FTP servers with direct T3 lines for large downloadable files. In this case, you might want to define a cluster for each protocol with a single port but many servers as shown in Figure 7 on page 95.

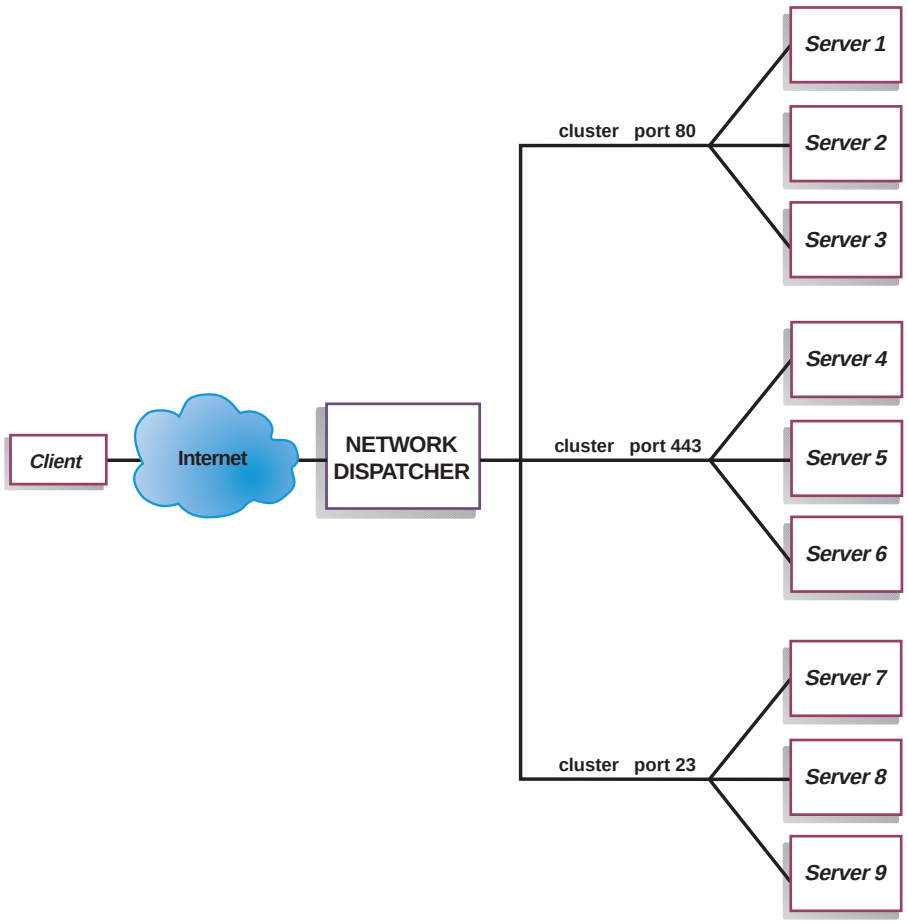


Figure 7. Example of Network Dispatcher Configured with 3 Clusters and 3 Ports

Configuration Steps

Before configuring Network Dispatcher:

1. Make sure that the Network Dispatcher has direct interfaces to servers. Servers can have independent connections to the enterprise router or Internet, such that the outgoing traffic from servers to clients can bypass the Network Dispatcher; however, you do not have to configure the independent connection.

   If high availability is important for your network, a typical high availability configuration is shown in Figure 8 on page 96.

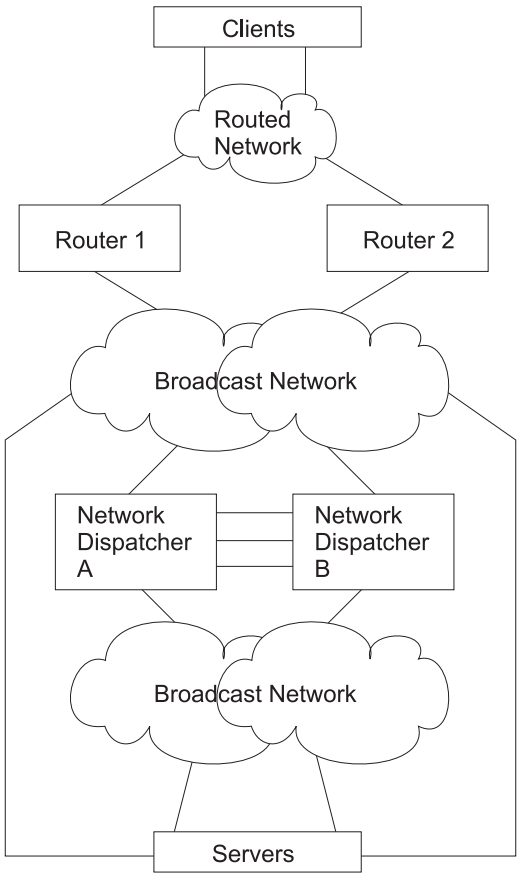


Figure 8. High Availability Network Dispatcher Configuration

2. Configure the interfaces of the device. This includes configuring all interfaces, IP addresses on all interfaces, and any applicable routing protocols. You must also configure an internal IP address, using the **set internal-ip-address**command. See *Protocol Configuration and Monitoring Reference Volume 1* for more information about the **set internal-ip-address.**
3. Reboot or restart the device.

Configuring Network Dispatcher on a IBM 2212

To configure Network Dispatcher on a IBM 2212:

1. Access the Network Dispatcher feature, using the **feature ndr** command.
2. Enable the executor and the manager using the **enable executor** and **enable manager** commands.
3. Configure the clusters using the **add cluster** command.
4. Configure the TCP and UDP destination ports using the **add port** command for each cluster of servers that will serve the corresponding protocol. Examples of the ports are: 80 for HTTP, 20 and 21 for FTP, and 23 for Telnet.
5. Configure the servers using the **add server** commands. A server is always associated with a port and a cluster. A server can serve more than one port, a port can be served on more than one server, and a server can belong to more than one cluster, if the server's operating system supports multiple aliasing.
6. Configure any advisors using the **add advisor** command.

Notes:

a. For the MVS advisor, do not define the Port Number value (default = 10007) under any cluster. This port number is used only by the MVS advisor to communicate with WLM in the MVS systems.

b. For the TN3270 advisor, two port values are entered. The Port Number value used for client-server communication (default = 23) must be defined under the appropriate clusters. Do not define the Communication Port value (default = 10008) under any cluster. The Communication Port value is used only by the TN3270 advisor to collect load information from the TN3270 servers.

7. Enable the advisors that you configured using the **enable advisor** command.

If you are configuring the Network Dispatcher for high availability, continue with the following steps. Otherwise, you have completed the configuration.

Note: Perform these steps on the primary Network Dispatcher and then on the backup. To ensure proper database synchronization, the executor in the primary Network Dispatcher must be enabled before the executor in the backup.

8. Configure whether this Network Dispatcher is a primary or backup and whether the switchover is manual or automatic using the **add backup** command.
9. Configure all paths on which the heartbeat is going to take place between the primary and backup Network Dispatchers using the **add heartbeat** command. A path is specified by source and destination IP addresses. Configuring more than one heartbeat path between the primary and backup Network Dispatchers is highly recommended to insure the failure of a single interface will not disrupt the heartbeat communication between the primary and backup machines.
10. Configure the list of host IP addresses that the Network Dispatcher must be able to reach in order to insure a full service, using the **add reach** command. Typically, this will be a subset of servers, the enterprise router, or an administration station.

You can change the configuration using the **set**, **remove**, and **disable** commands. See “Chapter 9. Configuring and Monitoring the Network Dispatcher Feature” on page 101 for more information about these commands.

Configuring a Server for Network Dispatcher

To configure the Network Dispatcher on a server:

1. Alias the loopback device.

   For the TCP and UDP servers to work, you must set (or preferably alias) the loopback device (usually called ***lo0***) to the cluster address. Network Dispatcher does not change the destination IP address in the IP packet before forwarding the packet to a server machine. When you set or alias the loopback device to the cluster address, the server machine will accept a packet that was addressed to the cluster address.

   It is important that the server use the cluster address rather than its own IP address to respond to the client. This is not a concern with TCP servers, but some UDP servers use their own IP address when they respond to requests that were sent to the cluster address. When the server uses its own IP address, some clients will discard the server’s response because it is not from an expected source IP address. You should use only UDP servers that use the destination IP address from the request when they respond to the client. In this case, the destination IP address from the request is the cluster address.

If you have an operating system that supports network interface aliasing such as AIX, Solaris, or Windows NT, you should alias the loopback device to the cluster address. The benefit of using an operating system that supports aliases is that you can configure the server machines to serve multiple cluster addresses.

If you have a server with an operating system that does not support aliases, such as HP-UX and OS/2, you must set ***lo0*** to the cluster address.

If your server is an MVS system running TCP/IP V3R2, you must set the VIPA address to the cluster address. This will function as a loopback address. The VIPA address must not belong to a subnet that is directly connected to the MVS node. If your MVS system is running TCP/IP V3R3, you must set the loopback device to the cluster address. If you are using high availability, you must enable RouteD in the MVS system so that the high availability takeover mechanism will function properly.

Note: The commands listed in this chapter were tested on the following operating systems and levels: AIX 4.1.5 and 4.2, HP-UX 10.2.0, Linux, OS/2 Warp Connect Version 3.0, OS/2 Warp Version 4.0, Solaris 2.5 (Sun OS 5.5), and Windows NT 3.51 and 4.0.

Use the command for your operating system as shown in Table 10 to set or alias the loopback device.

Table 10. Commands to alias the loopback device (lo0) for Dispatcher

System	Command
AIX	**ifconfig lo0 alias** *cluster_address*
HP-UX	**ifconfig lo0** *cluster_address*
Linux	**ifconfig lo:1 cluster_address netmask up**
OS/2	**ifconfig lo cluster_address**
Solaris	**ifconfig lo0:1 cluster_address 127.0.0.1 up**
Windows NT	a. Click Start, then click Settings. b. Click Control Panel, then double-click Network. c. If you have not done so already, add the MS Loopback Adapter Driver. 1) In the Network window, click Adapters. 2) Select MS Loopback Adapter, then click OK. 3) When prompted, insert your installation CD or disks. 4) In the Network window, click Protocols. 5) Select TCP/IP Protocol, then click Properties. 6) Select MS Loopback Adapter, then click OK. d. Set the loopback address to your cluster address. Accept the default subnet mask (255.0.0.0) and do not enter a gateway address. **Note:** You may have to exit and reenter Network Settings before the MS Loopback Driver shows up under TCP/IP Configuration.

2. Check for an extra route.

   On some operating systems a default route may have been created and needs to be removed.

   a. Check for an extra route on Windows NT with the following command: **route print**

   b. Check for an extra route on all UNIX systems and OS/2 with the following command: **netstat -nr**

c. Windows NT Example: After route print is entered, a table similar to the following will be displayed. (This example shows finding and removing an extra route to cluster 9.67.133.158 with a default netmask of 255.0.0.0.)

```
Active Routes:
       Network Address          Netmask  Gateway Address        Interface  Metric
               0.0.0.0          0.0.0.0      9.67.128.1      9.67.133.67     1
               9.0.0.0        255.0.0.0     9.67.133.158     9.67.133.158     1
            9.67.128.0    255.255.248.0      9.67.133.67      9.67.133.67     1
           9.67.133.67  255.255.255.255        127.0.0.1        127.0.0.1     1
          9.67.133.158  255.255.255.255        127.0.0.1        127.0.0.1     1
        9.255.255.255  255.255.255.255      9.67.133.67      9.67.133.67     1
            127.0.0.0        255.0.0.0        127.0.0.1        127.0.0.1     1
            224.0.0.0        224.0.0.0     9.67.133.158     9.67.133.158     1
            224.0.0.0        224.0.0.0      9.67.133.67      9.67.133.67     1
      255.255.255.255  255.255.255.255      9.67.133.67      9.67.133.67     1
```

d. Find your cluster address under the ″Gateway Address″ column. If you have an extra route, the cluster address will appear twice. In the example given, the cluster address (9.67.133.158) appears in row 2 and row 8.

e. Find the network address in each row in which the cluster address appears. You need one of these routes and will need to delete the other route, which is extraneous. The extra route to be deleted will be the one whose network address begins with the first digit of the cluster address, followed by three zeroes. In the example shown, the extra route is the one in row two, which has a network address of 9.0.0.0:

```
9.0.0.0         255.0.0.0      9.67.133.158      9.67.133.158      1
```

3. Delete any extra routes.

   Use the command from Table 11 for your operating system to delete any extra routes.

Table 11. Commands to Delete Routes for Various Operating Systems

Operating System	**Command**
AIX	**route delete -net** *network_address cluster_address*
HP-Unix	**route delete** *cluster_address cluster_address*
Solaris	No need to delete route.
OS/2	No need to delete route.
Windows NT	**route delete** *network_address cluster_address* **Note:** This command should be entered at an MS-DOS prompt.

Using Network Dispatcher with TN3270 Server

Network Dispatcher can be used with a cluster of 2210s, 2212s, Network Utilities or 2216s running TN3270 server function to provide TN3270e server support for large 3270 environments. The TN3270 advisor allows the Network Dispatcher to collect load statistics from each TN3270e server in real time to achieve the best possible distribution among the TN3270 servers. In addition to the TN3270 servers external to the Network Dispatcher router, one of the TN3270 servers in the cluster can be internal - it can run in the same router as Network Dispatcher.

Keys to Configuration

Configuration of the TN3270e servers is essentially the same whether or not you have a Network Dispatcher in front of the servers. In fact, the TN3270e server is unaware that the traffic from the clients is being dispatched through another

machine. However, there are some points to keep in mind when setting up the external TN3270 servers for use with Network Dispatcher:

- Since the Network Dispatcher does not alter the destination IP address in the packets (i.e. the cluster address) it forwards to the servers, the TN3270 server IP address in each server must be set equal to the cluster IP address.
- The routers running TN3270 server function must know the IP address of the TN3270 function running in the router in order to deliver packets to the server function. Therefore, the TN3270 server IP address (i.e. the cluster address) must also be defined on each TN3270 server router as either the internal IP address of the router, or as a secondary address on one of the router's interfaces.
- You must ensure that any routing protocols being used on the TN3270e servers (for example, OSPF or RIP) will not advertise the cluster address. The Network Dispatcher router must "own" the cluster address as far as the client network is concerned, so the Network Dispatcher router must be the only one advertising the cluster address.
- If the client to Network Dispatcher traffic flows on the same LAN as the Network Dispatcher to server traffic, you must make sure the servers do not respond to ARP for the cluster address, so the cluster address cannot be defined on the server's interface to this LAN. Network Dispatcher must be the only one responding to ARP on the LAN on which it receives client traffic.

When the TN3270 server is in the same router as Network Dispatcher, the TN3270 server IP address is set to the cluster address, but this address must not be defined on the router as the internal IP address or as an interface address.

Explicit LUs and Network Dispatcher

Special care has to be taken for explicit LU definition in a Network Dispatcher environment. A session request for either a implicit or a explicit LU can be dispatched to any server. This means that the explicit LU has to be defined in each server, since it is not known in advance to which server the session will be dispatched.

Chapter 9. Configuring and Monitoring the Network Dispatcher Feature

This chapter describes the Network Dispatcher Feature configuration and operational commands. It contains the following sections:

Accessing the Network Dispatcher Configuration Commands

To access the Network Dispatcher configuration environment:

1. Enter **talk 6** at the OPCON prompt (*).
2. Enter **feature ndr** at the `Config` > prompt.

Network Dispatcher Configuration Commands

Table 12 summarizes the Network Dispatcher configuration commands and the rest of the section explains these commands. Enter these commands at the `NDR Config` > prompt.

Table 12. Network Dispatcher 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 xxvi.
Add	Configures various components of the Network Dispatcher including advisors, clusters, ports, and servers.
Clear	Clears the entire Network Dispatcher configuration.
Disable	Disables the backup, executor, and manager components of the Network Dispatcher. Also disables specific advisors.
Enable	Enables the backup, executor, and manager components of the Network Dispatcher. Also enables specific advisors.
List	Displays the entire Network Dispatcher Configuration or specific portions of the configuration.
Remove	Removes specific portions of the Network Dispatcher configuration.
Set	Changes the configuration parameters for advisors, clusters, ports, servers, or the Network Dispatcher manager.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Add

Use the **add** command to configure advisors, clusters, ports, servers, and reach addresses. For High Availability you can also configure whether this Network Dispatcher is a primary or backup and which IP addresses to use for heartbeat and database synchronization.

Syntax:

add advisor . . .
backup . . .
cluster . . .
heartbeat . . .
port . . .
reach . . .
server . . .

Advisor *name port# interval timeout comm-port*
Specifies the name and port for an advisor. This parameter also specifies how frequently the advisor will collect information on a particular protocol and a time period after which the advisor considers the protocol unavailable.

name Specifies the type of advisor.

Table 13. Advisor Names and Port Numbers

Advisor Number	Advisor Name	Default Port#
0	FTP	21
1	HTTP	80
2	MVS	10007
3	TN3270	23
4	SMTP	25
5	NNTP	119
6	POPS	110
7	TELNET	23

Valid values: 0 - 7

Default value: 1

port# Specifies the port number for this advisor.

Valid values: 1 to 65535

Default values: See Table 13.

interval
Specifies the frequency, in seconds, with which the advisor queries its protocol for each server. After half of this value without a response from the server, the adviser considers the protocol unavailable.

Valid values: 0 to 65535

Default value: 5

timeout
Specifies the interval of time, in seconds, after which the advisor considers the protocol unavailable.

To make sure that out-of-date information is not used by the manager in its load-balancing decisions, the manager will not use information from the advisor whose time stamp is older than the time set in this parameter. The advisor timeout should be larger than the advisor polling interval. If the timeout is smaller, the manager will ignore reports that should be used. By default, advisor reports do not time out.

This timeout value typically applies if you disable an advisor. Do not confuse this parameter with the interval/2 timeout previously described, which relates to a server not responding.

Valid values: 0 to 65535

Default value: 0, which means the protocol is considered always available.

Comm-port
Specifies the port number used by the TN3270 advisor to communicate with the TN3270 servers. This parameter is input only for the TN3270 advisor.

Valid values: 1 to 65535

Default value: 10008

Example 1:

```
add advisor
Advisor name (0=ftp,1=http,2=MVS,3=TN3270,4=smtp,5=nntp,6=pop3,7=telnet) [1]? 1
Port number [80]?
Interval (seconds) [5]? 10
Timeout (0=unlimited) [0]? 10
```

Example 2:

```
add advisor
Advisor name (0=ftp,1=http,2=MVS,3=TN3270,4=smtp,5=nntp,6=pop3,7=telnet) [1]? 3
Port number [23]?
Interval (seconds) [5]? 10
Timeout (0=unlimited) [0]? 10
Communication Port number [10008]?
```

backup *role strategy*
Specifies whether this Network Dispatcher is a backup or primary.

role Defines whether this is a primary or a backup Network Dispatcher. Use this command only if you intend to have a redundant configuration, and want the High Availability function to run. In this case, you must also configure the heartbeat (**add heartbeat**) and reachability (**add reach**).

Valid values: 0 or 1

0 = primary

1 = backup

Default value: 0

strategy
Specifies whether the Network Dispatcher will switch back to primary mode automatically or manually. Whenever a Primary Network Dispatcher fails and becomes standby (which means a backup performed the IP takeover function), and then becomes available, it will automatically become the active Network Dispatcher if the strategy is set to *automatic*, as soon as the databases are synchronized. If strategy is set to *manual*, the old primary will go to standby mode and the operator must use the **switchover** command in talk 5 to make it active again. See “Switchover” on page 125.

Valid values: 0 or 1

0 = automatic

1 = manual

Default value: 0

Example:

```
add backup
Role (0=Primary, 1=Backup) [0]?
Switch back strategy (0=Auto, 1=Manual) [0]?
```

cluster *address FIN-count FIN-timeout Stale-timer*

Specifies a cluster's IP address and the frequency for the executor to perform garbage collection from the Network Dispatcher database.

address

Specifies the IP address for the cluster.

Valid values: Any valid IP address

Default value: 0.0.0.0

FIN-count

Specifies the number of connections that must be in FIN state before the executor tries to remove the unused connection information from the Network Dispatcher database after *FIN-timeout* or *Stale-timer* has elapsed.

Valid Values: 0 to 65535

Default value: 4000

FIN-timeout

Specifies the number of seconds, that a connection has been in the FIN state, after which the executor tries to remove the unused connection information from the Network Dispatcher database.

Valid Values: 0 to 65535

Default value: 30

Stale-timer

Specifies the number of seconds, that a connection has been inactive, after which the executor tries to remove a connection's information from the Network Dispatcher database.

Valid Values: 0 to 65535

Default value: 1500

Example:

```
NDR Config>add cluster
Cluster Address [0.0.0.0]? 113.3.1.12
FIN count [4000]?
FIN time out [30]?
Stale timer [1500]?
Cluster 113.3.1.12 has been added.
Fincount has been set to 4000 for cluster 113.3.1.12
Fintimeout has been set to 30 for cluster 113.3.1.12
Staletimer has been set to 1500 for cluster 113.3.1.12
NDR Config>
```

heartbeat *address1 address2*

Specifies one path for Heartbeat messages. It is recommended that you configure more than one entry for reliable behavior. The Heartbeat message will flow from *address1*, which belongs to this Network Dispatcher, to *address2*, which belongs to the peer Network Dispatcher.

address1
Specifies the IP address of the interface of this Network Dispatcher from which Heartbeat messages will flow.

Valid Values: Any IP address.

Default value: 0.0.0.0

address2
Specifies the IP address of the interface of the peer Network Dispatcher to which Heartbeat messages will flow. This address must be reachable from the interface specified in *address1.*

Valid Values: Any IP address.

Default value: 0.0.0.0

Example:

```
add heartbeat
Source Heartbeat address [0.0.0.0]? 131.2.25.90
Target Heartbeat Address [0.0.0.0]? 131.2.25.92
```

port *cluster-address port# port-type max-weight port-mode*
Specifies the port and port's attributes.

cluster-address
Specifies the IP address of the cluster.

Valid Values: Any IP address.

Default value: 0.0.0.0

port# Specifies the port number of the protocol for this cluster.

Valid Values: 1 to 65535

Default value: 80

port-type
Specifies the types of IP traffic that can be load balanced on this port. Supported types are:

- 1 = TCP
- 2 = UDP
- 3 = both

Valid Values: 1, 2, 3

Default value: 3

max-weight
Specifies the maximum weight for servers on this port. This affects how much difference there can be between the number of requests the executor will give each server.

Valid Values: 0 to 100

Default value: 20

port-mode
Specifies whether the port will feed all requests from a single client to a single server (known as sticky), use passive ftp (pftp), or use no particular protocols on this cluster (none).

Valid Values: 0 - 2, where

- 0 = none

- 1 = sticky
- 2 = pftp

Default value: 0

Example:

```
Config>feature ndr
NDR>add cluster 1.2.3.4 4000 30 1500
NDR>add port
Cluster address [0.0.0.0]? 1.2.3.4
Port number [80]? 80
Port type [3]?
Maximum weight [20]?
Port mode [0=none, 1=sticky, 2=pftp ]? 0
```

Wildcard characters can be used when specifying a URL mask. Wildcards can be used when configuring Network Dispatcher for the Web Server Cache or when using the **add** or **modify url** command from the `f webc` prompt. The characters used as wildcards are an * (asterisk) or a # (number sign). Wildcards can be used in any position as a part of the URL.

The * represents no characters or all characters as a part of that URL:

Example: *abc.html would filter the following URL masks.

```
abc.html
finabc.html
defchtjqsprabc.html
```

The # represents any single character.

Example: ab#.html would filter the follow URL masks.

```
abc.html
abf.html
abo.html
```

The following example applies when port mode 3 (`cache=3`) is selected and a new cache partition is not being added.

```
NDR Config>add port
Cluster Address  [0.0.0.0] ? 113.3.1.11
Port number  [80] ?
Max. weight (0-100)  [20] ?
Only one pftp port per cluster allowed
Port mode (none=0, sticky=1 pftp=2 cache=3)  0 ? 3
Do you want a new cache partition?  Yes : n
Enter cache partition  [0] ? 0
Maximum TCP segment size  (Range 512-32768 bytes)  4096 ?
Default server TCP connection timeout (Range 5-240 seconds)  120 ?
Default client TCP connection timeout (Range 5-240 seconds)  120 ?
Do you want to modify cache partition [0]?  No :
Requested port has been added to cluster 113.3.1.11
Maxweight has been set to 20 for port 80 in cluster 113.3.1.11
```

reach *address*

Specifies any host address that the Network Dispatcher must be able to reach to run correctly. It can be a server address, a router address, an administration station address or other IP host.

address

Specifies the target IP address.

Valid Values: Any IP address

Default value: 0.0.0.0

Example:

```
add reach
Address to reach [0.0.0.0]?
```

server *cluster-address port# server-address server-weight server-state*
Specifies the attributes of a server in a cluster.

cluster-address
Specifies the IP address of the cluster to which this server belongs.

Valid Values: Any IP address

Default value: 0.0.0.0

port# Specifies the protocol running over the connection to this server.

Valid Values: 1 to 65535

Default value: 80

server-address
Specifies the IP address of the server.

Valid Values: Any IP address

Default value: 0.0.0.0

server-weight
Specifies the weight of the server for the executor. This affects how frequently the Network Dispatcher sends requests to this particular server.

Valid Values: 0 to the value of *max-weight* specified on the add port command.

Default value: max-weight on port command

server-state
Specifies whether the executor should regard the server as available or unavailable when the executor begins processing.

Valid Values: 0 (down) or 1 (up)

Default value: 1

Example:

```
add server
Cluster address [0.0.0.0]? 131.2.25.91
Port number [80]? 80
Server address [0.0.0.0]? 131.2.25.94
Server weight [35]?
Server state (down=0 up=1) [1]?
```

Parameter Configuration Limits

Table 14 lists the limits for the various items you can configure for a Network Dispatcher.

Table 14. Parameter Configuration Limits

Parameter	Limit
Advisors	8 per 2212
Clusters	32 per 2212
Heartbeats	8 per 2212
Ports	8 per cluster
Reachs	8 per 2212
Servers	32 per configured port, 128 for each port number under all clusters configured.

Table 14. Parameter Configuration Limits (continued)

Unique server IP address	32 per port

Clear

Use the **clear** command to clear the entire Network Dispatcher configuration.

Syntax:

clear

Disable

Use the **disable** command to disable a Network Dispatcher component.

Syntax:

disable advisor . . .
backup
executor
manager

advisor *name port#*

Disables an advisor from the Network Dispatcher.

name Specifies the type of advisor.

See Table 13 on page 102 for additional information.

Valid values: 0 - 7

Default value: 0

port# Specifies the port number for this advisor.

Valid values: 1 to 65535

Default value: None. You must enter a port number.

Example:

```
disable advisor
Advisor name (0=ftp,1=http,2=MVS,3=TN3270,4=smtp,5=nntp,6=pop3,7=telnet) [1]? 1
Port number [0]? 80
```

backup

Disables the Network Dispatcher's backup function.

Example:

```
disable backup
Backup is now disabled.
```

executor

Disables the Network Dispatcher executor. Disabling the executor disables the Network Dispatcher feature.

Example:

```
disable executor
Executor is now disabled.
```

Note: Disabling the executor will stop the manager, advisors, and the high availability function, if they are currently running.

manager

Disables the Network Dispatcher manager. The manager is an optional component. However, if you do not use the manager, the Network Dispatcher will balance the load using a round-robin scheduling method based on the current server weights.

Example:

```
disable manager
Manager is now disabled.
```

Note: Because the manager component is prerequisite for advisors, disabling the manager will stop all the advisors from running.

Enable

Use the **enable** command to enable a Network Dispatcher component.

Syntax:

enable advisor . . .
backup
executor
manager

advisor *name port#*

Enables an advisor to the Network Dispatcher.

name Specifies the type of advisor.

See Table 13 on page 102 for additional information.

Valid values: 0 - 7

Default value: 0

port# Specifies the port number for this advisor.

Valid values: 1 to 65535

Default value: None. You must enter a port number.

Example:

```
enable advisor
Advisor name (0=ftp,1=http,2=MVS,3=TN3270,4=smtp,5=nntp=6=pop3,7=telnet) [1]? 1
Port number [0]? 80
```

Note: Because the manager component is a prerequisite for the advisor, you must enable the manager before any advisor can be enabled. You must also set the internal ip address using the **set internal-ip-address** command for the advisor to run correctly. See *Protocol Configuration and Monitoring Reference Volume 1* for more information about the **set internal-ip-address.** command.

backup

Enables the Network Dispatcher's backup function.

Example: `enable backup`

Note: Before enabling backup, you must add at least one heartbeat

executor

Enables the Network Dispatcher executor.

Example:

```
enable executor
Executor is now enabled.
```

manager

Enables the Network Dispatcher manager.

Example:

```
enable manager
Manager interval was set to 2.
Manager proportions were set to  50   50   0   0
Manager refresh cycle was set to 2
Manager sensitivity was set to 5.
Manager smoothing factor was set to 1.50.
```

When the manager is enabled for the first time, a manager record is created with the following default values:

Interval:	2 seconds
Refresh-Cycle:	2
Sensitivity:	5 %
Smoothing:	1.5
Proportions:	
Active:	50%
New:	50%
Advisor:	0
System:	0

See “Set” on page 114 for a description of the above parameters.

List

Use the **list** command to display information about the Network Dispatcher.

Syntax:

list all | advisor | backup | cluster | manager | port | server

all Displays all Network Dispatcher configuration information. This includes the same information displayed for advisors, backup, cluster, manager, ports, and servers.

Example:

```
NDR Config> list all

Executor: Enabled

Manager: Enabled

        Interval        Refresh-Cycle   Sensitivity     Smoothing
        2               2               5 %             1.50
        Proportions:    Active  New     Advisor         System
                        50 %    50 %    0 %             0 %

Advisor:
        Name    Port    Interval        TimeOut         State     CommPort
        http    80      5               0               Enabled
        MVS     10007   15              0               Enabled
        TN3270  23      5               0               Enabled   10008

Backup: Enabled
        Role            Strategy
        PRIMARY         AUTOMATIC

        Reachability:   Address         Mask            Type
                        131.2.25.93     255.255.255.255 HOST
                        131.2.25.94     255.255.255.255 HOST

        HeartBeat Configuration:
           Source Address:  131.2.25.90 Target Address:   131.2.25.92
           Source Address:  132.2.25.90 Target Address:   132.2.25.92

Clusters:
        Cluster-Addr    FIN-count       FIN-timeout     Stale-timer
        131.2.25.91     4000            30              1500

Ports:
  Cluster-Addr    Port#   Weight  Port-Mode  Port-Type
  131.2.25.91     23      20 %    none       TCP
  131.2.25.91     80      20 %    none       Both

Servers:
        Cluster-Addr    Port#   Server-Addr     Weight  State
        131.2.25.91     23      131.2.25.93     20 %    up
        131.2.25.91     23      131.2.25.94     20 %    up
        131.2.25.91     80      131.2.25.93     20 %    up
        131.2.25.91     80      131.2.25.94     20 %    up
```

advisor
Displays the configuration for the Network Dispatcher advisors.

backup
Displays the backup configuration for the Network Dispatcher.

cluster
Displays the configuration of the Network Dispatcher clusters.

manager
Displays the configuration of the Network Dispatcher manager.

port Displays the configuration of the Network Dispatcher ports.

server Displays the configuration of the servers associated with the Network Dispatcher clusters.

Remove

Use the **remove** command to delete part of the Network Dispatcher configuration.

Syntax:

remove advisor . . .
backup
cluster . . .
heartbeat . . .
port . . .

reach . . .

server . . .

advisor *name port#*

Removes a specific advisor from the Network Dispatcher configuration.

name Specifies the type of advisor.

See Table 13 on page 102 for additional information.

Valid values: 0 - 7

Default value: 0

port# Specifies the port number for this advisor.

Valid values: 1 to 65535

Default value: None. You must enter a port number.

Example:

```
remove advisor
Advisor name (0=ftp,1=http,2=MVS,3=TN3270,4=smtp,5=nntp,6=pop3,7=telnet) [0]?
Advisor port [0]? 80
```

backup

Removes the high availability function.

Note: Because backup is a prerequisite for the heartbeat and reach functions removing backup will stop heartbeat and reach from running.

Example: `remove backup`

cluster *address*

Removes a cluster from the Network Dispatcher configuration.

address

Specifies the IP address for the cluster.

Valid values: Any valid IP address

Default value: 0.0.0.0

Note: Removing a cluster address also removes all the ports and servers associated with that cluster.

Example:

```
remove cluster
WARNING: Deleting a cluster will make any port or server
         associated with it to also be deleted.
Cluster address [0.0.0.0]? 131.2.25.91
```

heartbeat *address*

Removes the heartbeat address from the Network Dispatcher configuration.

address

Specifies the IP address for the target Network Dispatcher.

Valid values: Any valid IP address

Default value: 0.0.0.0

Example:

```
remove heartbeat
Target address [0.0.0.0]? 131.2.25.92
```

port *cluster-address port#*

Removes a port from a specific cluster in the Network Dispatcher configuration.

cluster-address

Specifies the IP address of the cluster.

Valid Values: Any IP address.

Default value: 0.0.0.0

port# Specifies the port number of the protocol for this cluster.

Valid Values: 1 to 65535

Default value: None. You must enter a port number.

Note: Removing a port will also remove all of the servers associated with that port.

Example:

```
remove port
WARNING: Deleting a port will make any server
associated with it also be deleted.   [0.0.0.0]? 7.82.142.15
Port number [0]? 80
Cluster address [0.0.0.0]? 20.21.22.15
```

reach *address*

Removes a server from the list of hosts the Network Dispatcher must be able to reach.

address

Specifies the IP address of the cluster.

Valid Values: Any IP address.

Default value: 0.0.0.0

Example:

```
remove reach
Target address [0.0.0.0]? 9.82.142.15
```

server *cluster-address port# server-address*

Removes a server from a cluster and port in the Network Dispatcher configuration.

cluster-address

Specifies the IP address of the cluster.

Valid Values: Any IP address.

Default value: 0.0.0.0

port# Specifies the port number of the protocol for this cluster.

Valid Values: 1 to 65535

Default value: None. You must enter a port number.

server-address

Specifies the IP address of the cluster.

Valid Values: Any IP address.

Default value: 0.0.0.0

Example:

```
remove server
Cluster address [0.0.0.0]? 7.82.142.15
Port number [0]? 80
Server address [0.0.0.0]? 20.21.22.15
```

Set

Use the **set** command to change the attributes of an existing advisor, cluster, port, or server. You can also define attributes for the Network Dispatcher manager.

Syntax:

set advisor . . .
cluster . . .
manager . . .
port . . .
server . . .

advisor *name port# interval timeout comm-port*
Changes the port number, interval, and timeout for an advisor.

name Specifies the type of advisor.

See Table 13 on page 102 for additional information.

Valid values: 0 - 7

Default value: 0

port# Specifies the port number for this advisor.

Valid values: 1 to 65535

Default value: None. You must enter a port number.

interval
Specifies the frequency with which the advisor queries its protocol for each server. After half of this value expires without a response from the server, the adviser considers the protocol unavailable.

Valid values: 0 to 65535

Default value: 5

timeout
Specifies the interval of time, in seconds, after which the advisor considers the protocol unavailable.

To make sure that out-of-date information is not used by the manager in its load-balancing decisions, the manager will not use information from the advisor whose time stamp is older than the time set in this parameter. The advisor timeout should be larger than the advisor polling interval. If the timeout is smaller, the manager will ignore reports that should be used. By default, advisor reports do not time out.

This timeout value typically applies if you disable an advisor. Do not confuse this parameter with the interval/2 timeout previously described, which relates to a server not responding.

Valid values: 0 to 65535

Default value: 0, which means the protocol is considered always available.

comm-port
Specifies the port number used by the TN3270 advisor to communicate with the TN3270 servers. This parameter is input only for the TN3270 advisor.

Valid values: 1 to 65535

Default value: 10008

Example:

```
set advisor
Advisor name (0=ftp,1=http,2=MVS,3=TN3270,4=smtp,5=nntp=6=pop3,7=telnet) [0]?
Port number [0]? 21
Interval (seconds) [5]? 10
Timeout (0=unlimited) [0]? 20
```

cluster *address FIN-count FIN-timeout Stale-timer*
Changes the FIN-count, FIN-timeout, and Stale-timer for a cluster in the Network Dispatcher configuration.

address
Specifies the IP address for the cluster.

Valid values: Any valid IP address

Default value: 0.0.0.0

FIN-count
Specifies the number of connections that must be in FIN state before the executor tries to remove the unused connection information from the Network Dispatcher database after *FIN-timeout* or *Stale-timer* has elapsed.

Valid Values: 0 to 65535

Default value: 4000

FIN-timeout
Specifies the number of seconds after which the executor tries to remove the unused connection information from the Network Dispatcher database.

Valid Values: 0 to 65535

Default value: 30

Stale-timer
Specifies the number of seconds that a connection has been inactive, after which the executor tries to remove a connection's information from the Network Dispatcher database.

Valid Values: 0 to 65535

Default value: 1500

Example:

```
set cluster
Cluster address [0.0.0.0]? 131.2.25.91
FIN count [4000]? 4500
FIN timeout [30]? 40
Stale timer [1500]? 2000
```

manager *interval proportion refresh sensitivity smoothing*

Sets the values that the manager uses to determine the best server to satisfy a request.

interval

Specifies the amount of time, in seconds, after which the manager updates the server weights that the executor uses in load balancing connections.

Valid values: 0 to 65535

Default value: 2

proportion

Specifies the relative importance of external factors in the manager's weighting decisions. The sum of the proportions must equal 100. The factors are:

active The number of active connections on each TCP/IP server as tracked by the executor.

Valid values: 0 to 100

Default value: 50

new The number of new connections on each TCP/IP server as tracked by the executor.

Valid values: 0 to 100

Default value: 50

advisor

Input from the protocol advisors defined to the Network Dispatcher.

Valid values: 0 to 100

Default value: 0

system

Input from the MVS system advisor provided by the MVS WLM system monitoring tool.

Valid values: 0 to 100

Default value: 0

refresh

Specifies the frequency with which the manager requests status from the executor. This parameter is specified as a number of *intervals*.

Valid values: 0 to 100

Default value: 2

sensitivity

Specifies the percentage weight change for all the servers on a port, after which the manager updates the weights that the executor uses in load balancing connections.

Valid values: 0 to 100

Default value: 5

smoothing

Specifies a limit to the amount that a server's weight can change. Smoothing minimizes the frequency of change in the distribution of requests. A higher smoothing index will cause the weights to change less. A lower smoothing index will cause the weights to change more.

Valid values: a decimal value between 1.0 and 42 949 673.00

Default value: 1.5

Note: You can only specify two places after the decimal point.

Example:

```
set manager
Interval (in seconds) [2]? 3
Active proportion [50]? 40
New proportion [50]? 38
Advisor proportion [0]? 20
System proportion [0]? 2
Refresh cycle [2]? 4
Sensitivity threshold [5]? 10
Smoothing index (>1.00) [1.50]? 200
```

port *cluster-address port# port-type max-weight port-mode*

Changes the port-type, max-weight, and port-mode for a specific cluster and port number.

cluster-address

Specifies the IP address of the cluster.

Valid Values: Any IP address.

Default value: 0.0.0.0

port# Specifies the port number of the protocol for this cluster.

Valid Values: 1 to 65535

Default value: None. You must enter a port number.

port-type

Specifies the type of IP traffic that can be load balanced on this port.

Valid Values:

tcp=1

upd=2

both=3

Default value: 3

max-weight

Specifies the weight for servers on this port. This affects how much difference there can be between the number of requests the executor will give each server.

Valid Values: 0 to 100

Default value: 20

port-mode

Specifies whether the port will feed all requests from a single client to a single server (known as sticky), use passive ftp (pftp), or use no protocols on this cluster (none).

Valid Values:

none=0

sticky=1

pftp=2

Default value: 0 (none)

Example:

```
set port
Cluster address [0.0.0.0]? 131.2.25.91
Port number [0]? 23
Port type (tcp=1, udp=2, both=3) [0]?
Max. weight (0-100) [20]? 30
Only one pftp port per cluster allowed
Port mode (none=0, sticky=1, pftp=2) []?
```

server *cluster-address port# server-address weight state*

Changes the server state, and server weight for a specific server in a cluster.

cluster-address

Specifies the IP address of the cluster to which this server belongs.

Valid Values: Any IP address

Default value: 0.0.0.0

port# Specifies the port number of the protocol for this cluster.

Valid Values: 1 to 65535

Default Value: None. You must enter a port number.

server-address

Specifies the IP address of the server.

Valid Values: Any valid server address

Default Value: 0.0.0.0

state Specifies whether the executor should regard the server as available or unavailable when the executor begins processing.

Valid Values: 0 (down) or 1 (up)

Default value: 1

weight

Specifies the weight of the server for the executor. This affects how frequently the Network Dispatcher sends requests to this particular server.

Valid Values: 0 to the value of *max-weight* specified on the add port command.

Default value: max-weight on port command

Example:

```
set server
Cluster address [0.0.0.0]? 131.2.25.91
Port number [0]?
Server address [0.0.0.0]?
Server weight [20]? 25
Server state (down=0, up=1) [1]? 1
```

Accessing the Network Dispatcher Monitoring Commands

To access the Network Dispatcher monitoring environment:

1. Enter **talk 5** at the OPCON prompt (*).
2. Enter **feature ndr** at the GWCON prompt (+).

Network Dispatcher may also be monitored using SNMP. Refer to "SNMP Management" in the *Protocol Configuration and Monitoring Reference Volume 1* for more information.

Network Dispatcher Monitoring Commands

Table 15 summarizes the Network Dispatcher monitoring commands and the rest of the section explains these commands. Enter these commands at the `NDR >` prompt.

Table 15. Network Dispatcher 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 xxvi.
List	Displays the currently configured attributes of the advisor, clusters, ports, or servers.
Quiesce	Specifies that no more connection request should be sent to a server. Also temporarily stops the heartbeat and reach functions.
Report	Displays a report of information related to the advisor and the manager.
Status	Displays the current status of the counters, clusters, ports, servers, advisor, manager, and backup.
Switchover	Forces a Network Dispatcher that is running in standby mode to become the active Network Dispatcher. Use of this command is necessary if you specified manual as the switchover mode.
Unquiesce	Allows the Network Dispatcher manager to assign a weight greater than 0 to a previously quiesced server on every port that the server is configured. This action allows new connection requests to flow to the selected server.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

List

Use the **list** command to display information about the Network Dispatcher.

Syntax:

list advisor
cluster
port
server

advisor

Displays the configuration for the Network Dispatcher advisors.

Example:

```
list advisor
Advisor list requested.
```

```
-----------------------------------------
| ADVISOR |  PORT  |  TIMEOUT  |  STATUS  |
-----------------------------------------
|  ftp    |    21  |       5   |  ACTIVE  |
|  Http   |    80  | unlimited |  ACTIVE  |
|  MVS    | 10007  | unlimited |  ACTIVE  |
|  TN3270 |    23  | unlimited |  ACTIVE  |
-----------------------------------------
```

cluster

Displays the configuration of the Network Dispatcher clusters.

Example:

```
list cluster
EXECUTOR INFORMATION:
 --------------------
Version: 01.01.00.00 - Tue Dec 10 14:15:58 EST 1996
Number of defined clusters: 2

CLUSTER LIST:
-------------
  131.2.25.91
  10.11.12.2
```

port Displays the configuration of the Network Dispatcher ports.

Example:

```
list port
Cluster Address [0.0.0.0]? 131.2.25.91

 ------------------------------------------------------
| CLUSTER:       131.2.25.91                           |
|------------------------------------------------------|
|   PORT   |    MAXWEIGHT   |  PORT MODE  |  PORT TYPE  |
|------------------------------------------------------|
|     23   |         30     |    none     |     TCP     |
|     80   |         20     |    none     |     both    |
 ------------------------------------------------------
```

server Displays the configuration of the servers associated with the Network Dispatcher clusters.

Example:

```
list server
Cluster Address [0.0.0.0]? 131.2.25.91

PORT 23 INFORMATION:
 --------------------
Maximum weight.................. 20
Port mode....................... NONE
Port type....................... TCP
All up nodes are weight zero.... FALSE
Total target nodes.............. 2
Currently marked down........... 0
Servers providing service to this port:
Address: 131.2.25.93 Weight: 20 Count: 0 TCP Count: 0 UPD Count: 0 Active: 0 FIN 0 Complete 0 Status: up S
Address: 131.2.25.94 Weight: 20 Count: 0 TCP Count: 0 UPD Count: 0 Active: 0 FIN 0 Complete 0 Status: up S

PORT 80 INFORMATION:
 --------------------
Maximum weight.................. 20
Port mode....................... NONE
Port type....................... BOTH
All up nodes are weight zero.... FALSE
Total target nodes.............. 2
Currently marked down........... 0
Servers providing service to this port:
Address: 131.2.25.93 Weight: 20 Count: 0 TCP Count: 0 UPD Count: 0 Active: 0 FIN 0 Complete 0 Status: up S
Address: 131.2.25.94 Weight: 20 Count: 0 TCP Count: 0 UPD Count: 0 Active: 0 FIN 0 Complete 0 Status: up S
```

Quiesce

Use the **quiesce** command to temporarily stop the heartbeat or reach functions or to specify that no more connection requests should be sent to a server.

Syntax:

quiesce heartbeat
manager
reach

heartbeat *address*
Stops the selected path for the heartbeat function. The *address* is the IP address of the remote network dispatcher to which this Network Dispatcher is sending Heartbeat messages.

Example:

```
quiesce heartbeat
Remote Address [0.0.0.0]? 131.2.25.94
```

manager *address*
Specifies that no more connection requests are to be made to the specified server. *Address* is the IP address of the server.

Example:

```
quiesce manager
Server Address [0.0.0.0]? 131.2.25.93
```

reach *address*
Stops the Network Dispatcher's polling of the specified address to determine if it is reachable, where *address* is the IP address that is part of the reachability criteria.

Example:

```
quiesce reach
Reach Address [0.0.0.0]? 131.2.25.92
```

Report

Use the **report** command to display a report of the advisor or manager

Syntax:

report advisor
manager

advisor *type port#*
Displays a report of information about a specific advisor.

type Is the type of advisor. See Table 13 on page 102 for advisor types.

port# Is the port number.

Example:

```
report advisor
0=ftp,1=http,2=MVS,3=TN3270,4=smtp,5=nntp,6=pop3,7=telnet
Advisor name [0]? 1
Port number [0]? 80

-------------------------------
|      ADVISOR:     http      |
|      PORT:          80      |
-------------------------------
| 131.2.25.93      |       0  |
| 131.2.25.94      |      16  |
-------------------------------
```

manager
Displays a report of the current manager information.

Example:

```
report manager

---------------------------------
|  HOST TABLE LIST  |   STATUS   |
---------------------------------
|  131.2.25.93      |    ACTIVE  |
|  131.2.25.94      |    ACTIVE  |
---------------------------------

-------------------------------------------------------------------------------
|131.2.25.91    |WEIGHT | ACTIVE % 50  |  NEW % 50    | PORT %  0 |SYSTEM %  0|
|               ---------------------------------------------------------------|
|PORT:   23     |NOW|NEW| WT | CONNECT | WT | CONNECT | WT | LOAD | WT | LOAD |
-------------------------------------------------------------------------------
|131.2.25.93    | 10| 10|  10|        0|  10|        0|   0|     0|-999|    -1|
|131.2.25.94    | 10| 10|  10|        0|  10|        0|   0|     0|-999|    -1|
|---------------------------------------------------------------------------|
|PORT TOTALS:   | 20| 20|    |        0|    |        0|    |     0|    |    -2|
-------------------------------------------------------------------------------


-------------------------------------------------------------------------------
|131.2.25.91    |WEIGHT | ACTIVE % 50  |  NEW % 50    | PORT %  0 |SYSTEM %  0|
|               ---------------------------------------------------------------|
|PORT:   80     |NOW|NEW| WT | CONNECT | WT | CONNECT | WT | LOAD | WT | LOAD |
-------------------------------------------------------------------------------
|131.2.25.93    | 10| 10|  10|        0|  10|        1|  16|     0|-999|    -1|
|131.2.25.94    | 10| 10|  10|        0|  10|        1|   3|    16|-999|    -1|
|---------------------------------------------------------------------------|
|PORT TOTALS:   | 20| 20|    |        0|    |        0|    |    16|    |    -2|
-------------------------------------------------------------------------------


-------------------------------------------
| ADVISOR |  PORT  |  TIMEOUT  |  STATUS  |
-------------------------------------------
|  http   |    80  | unlimited |   ACTIVE |
|  MVS    | 10007  | unlimited |   ACTIVE |
-------------------------------------------
Manager report requested.
```

Status

Use the **status** command to obtain the status of the advisors, backup, counter, clusters, manager, ports, and servers.

Syntax:

status advisor
backup
cluster
counter
manager
ports
servers

advisor *name port#*

Obtains the status of a specific advisor.

name Specifies the type of advisor. See Table 13 on page 102 for advisor types.

port# Is the port number.

Example:

```
status advisor
0=ftp, 1=http, 2=MVS 3=TN3270, 4=SMTP, 5=NNTP, 6=POP3, 7=TELNET
Advisor name [0]?
Port number [0]? 21
```

```
Advisor ftp on port 21 status:
==============================
Interval.................. 10
```

backup

Obtains the status of the backup function.

Example:

```
status backup
 Dumping status ...
 Role : PRIMARY   Strategy : AUTOMATIC  State : ND_ACTIVE Sub-State : ND_SYNCHRONIZED
 <<Preferred Target : 132.2.25.92>>

 Dumping HeartBeat Status ...
 .....Heartbeat target : 131.2.25.92 Status : UNREACHABLE
 .....Heartbeat target : 132.2.25.92 Status : REACHABLE

 Dumping Reachability Status ...
 .....Host:131.2.25.93   Local:REACHABLE
 .....Host:131.2.25.94   Local:REACHABLE
```

cluster *address*

Obtains the status of a specified cluster, where *address* is the IP address of the cluster.

Example:

```
status cluster
Cluster Address [0.0.0.0]? 131.2.25.91

EXECUTOR INFORMATION:
 ---------------------
Version: 01.01.00.00 - Tue Dec 10 14:15:58 EST 1996

CLUSTER INFORMATION:
 --------------------
Address......................... 131.2.25.91
Number of target ports.......... 2
FIN clean up count.............. 4000
Connection FIN timeout.......... 30
Active connection stale timer... 1500

PORT 23 INFORMATION:
 --------------------
Maximum weight.................. 20
Port mode....................... NONE
Port type....................... TCP
All up nodes are weight zero.... FALSE
Total target nodes.............. 2
Currently marked down........... 0
Servers providing service to this port:
Address: 131.2.25.93 Weight: 20 Count: 0 Active: 0 FIN 0 Status: up Saved Weight: -1
Address: 131.2.25.94 Weight: 20 Count: 0 Active: 0 FIN 0 Status: up Saved Weight: -1

PORT 80 INFORMATION:
 --------------------
Maximum weight.................. 20
Port type....................... BOTH
Port mode....................... NONE
All up nodes are weight zero.... FALSE
Total target nodes.............. 2
Currently marked down........... 0
Servers providing service to this port:
Address: 131.2.25.93 Weight: 20 Count: 0 Active: 0 FIN 0 Status: up Saved Weight: -1
Address: 131.2.25.94 Weight: 20 Count: 0 Active: 0 FIN 0 Status: up Saved Weight: -1
```

counter

Obtains the status of all counters.

Example:

```
status counter
Internal counters from executor:
--------------------------------
Total number of packets into executor...... 2684
Total packets for cluster processing (C)... 2684
Packets not addressed to a cluster(port)... 0

Cluster processing results:
---------------------------
Errors..................................... 0
```

```
Discarded.................................. 0
Forward requested.......................... 2684
Forward requested.......................... 0
Forward discarded with error............... 0

Other processing problems:
--------------------------
Total packets dropped (C).................. 0
```

manager

Obtains the status of the manager.

Example:

```
status manager
Number of defined hosts... 2
Sensitivity.............. 0%
Smoothing factor......... 2
Interval................. 3
Weights refresh cycle..... 4

Active connections gauge proportion......... 40%
New connections counter(delta) proportion... 38%
Advisor gauge proportion.................... 20%
System Metric proportion....................  2%

Manager status requested.
```

port *cluster-address port#*

Obtains the status of a specific port, where:

cluster-address
is the IP address of the cluster.

port# is the port number on the cluster.

Example:

```
status port
Cluster Address [0.0.0.0]? 131.2.25.91
Port number  [0]? 80

PORT 80 INFORMATION:
 --------------------
Maximum weight.................. 20
Port mode....................... NONE
Port type....................... BOTH
All up nodes are weight zero.... FALSE
Total target nodes.............. 2
Currently marked down........... 0
Servers providing service to this port:
Address: 131.2.25.93 Weight: 20 Count: 12345 TCP Count: 10000 UDP count 2345 Active: 3431 FIN 3780 Complete
Address: 131.2.25.94 Weight: 20 Count: 7890  Active: 2980 FIN 2390 Status: up Saved Weight: -1
```

server *address*

Obtains the status of a specific server, where *address* is the IP address of the cluster to which the server belongs.

Example:

```
status server
Cluster Address [0.0.0.0]? 131.2.25.91

PORT 23 INFORMATION:
 --------------------
Maximum weight.................. 20
Port mode....................... NONE
Port type....................... TCP
All up nodes are weight zero.... FALSE
Total target nodes.............. 2
Currently marked down........... 0
Servers providing service to this port:
Address: 131.2.25.93 Weight: 20 Count: 140 TCP Count: 100 UDP Count: 40  Active: 50 FIN 45 Complete 50  Stat
Address: 131.2.25.94 Weight: 20 Count: 250 TCP Count: 100 UDP Count: 40  Active: 60 FIN 54 Complete 50  Stat

PORT 80 INFORMATION:
 --------------------
Maximum weight.................. 20
Port mode....................... NONE
Port type....................... BOTH
```

```
All up nodes are weight zero.... FALSE
Total target nodes.............. 2
Currently marked down........... 0
Servers providing service to this port:
Address: 131.2.25.93 Weight: 20 Count: 12345 TCP Count: 10000 UDP Count: 2345  Active: 3431 FIN 3780 Comp
Address: 131.2.25.94 Weight: 20 Count: 7890  TCP Count: 10000 UDP Count: 2345  Active: 2980 FIN 2390 Comp
```

Switchover

Use the **switchover** command to force a Network Dispatcher that is running in standby mode to become the active Network Dispatcher when the switchover strategy is manual. This command must be entered on the host that is running the Network Dispatcher that is in standby mode.

Syntax:

switchover

Unquiesce

Use the **unquiesce** command to restart a heartbeat, manager, or reach function that was previously stopped with the **quiesce** command.

Syntax:

unquiesce heartbeat
manager
reach

heartbeat *address*

Restarts the path for Heartbeat messages, where *address* is the IP address of the remote network dispatcher to which this Network Dispatcher is sending Heartbeat messages.

Example:

```
unquiesce heartbeat
Remote Address [0.0.0.0]? 9.10.11.1
```

manager *address*

Restarts sending connection requests to the specified server. *Address* is the IP address of the server.

Example:

```
unquiesce manager
Server Address [0.0.0.0]? 20.21.22.15
```

reach *address*

Restarts the Network Dispatcher's polling of the specified address to determine if it is reachable, where *address* is the IP address that is part of the reachability criteria.

Example:

```
unquiesce reach
Reach address [0.0.0.0]? 20.3.4.5
```

Chapter 10. Using the Data Compression Subsystem

This chapter discusses data compression on a 2212 over Frame Relay and PPP interfaces. It includes these sections:

- "Data Compression Overview"
- "Data Compression Concepts"

Data compression is supported on Frame Relay and PPP interfaces.

Data Compression Overview

The data compression system provides a means to increase the effective bandwidth of networking interfaces on the device. It is primarily intended for use on slower speed WAN links.

Data compression on the device is supported on PPP and Frame Relay interfaces:

- For PPP interfaces, compression is implemented according to the Compression Control Protocol (CCP) as defined in the Internet Engineering Task Force's RFC 1962. CCP provides the underlying mechanisms by which the use of compression is negotiated and a means for choosing among multiple possible compression algorithms or protocols.

  The device provides two compression protocols: the Stac-LZS protocol, defined in RFC 1974; and the Microsoft Point-to-Point Compression protocol (MPPC), described in RFC 2118. Both of these are based on compression algorithms provided by Stac Electronics.
- For Frame Relay interfaces, compression is implemented according to FRF.9, the *Data Compression over Frame Relay Implementation Agreement* produced by the Frame Relay Forum Technical Committee. FRF.9 describes a Data Compression Protocol (DCP), modeled after PPP's CCP, and similarly provides a means for negotiating various compression algorithms and options. The device supports DCP "mode 1" negotiation. FRF.9 also describes a more generalized "mode 2"; this is not supported. Compression itself is done using the same compression engine as used for the PPP Stac-LZS protocol.

Data Compression Concepts

Data compression on the device provides a means to increase throughput on network links by making more efficient use of the available bandwidth on a link. The basic principle behind this is simple: represent the data flowing across a link in as compact a manner as possible so that the time needed to transmit it is as low as possible, given a set speed on a link.

Data compression may be performed at many layers in the networking model. At one end of the spectrum, applications may compress data prior to transmitting it to peer applications elsewhere in the network, while at the other end of the spectrum devices may be performing compression at the data link layer, working purely on the bit stream passing between two nodes. How this compression is done and how effective it is depends on a variety of factors, including such things as what network layer the compression is performed at, how much intrinsic knowledge the compressor and decompressor have about the data being compressed, the compression algorithm chosen, and the actual data being compressed. The best

compression can usually be performed at the application layer; for example, a file transfer application usually has the luxury of having an entire file of data available to it prior to attempting compression, and it may be able to try different compression algorithms on the file to see which performs best on that particular file's data. Although this may provide excellent compression for that one type of application, it does little to solve the general problem of compressing the bulk of the traffic flowing over a network, as most networking applications do not currently compress data as they generate it.

Compression on the device takes place at a much lower networking layer, at the data link layer. In the device, compression is performed on the individual packets which are transmitted across a link. The compression is done in real-time as packets flow through the device: the sender compresses a packet just prior to transmitting it, and the decompressor decompresses the packet as soon as it receives it. This operation is transparent to the higher layer networking protocols.

Data Compression Basics

Data compressors work by recognizing "redundant" information in data, and producing a different set of data which contains as little redundancy as possible. "Redundant" information is any information which can be derived and recreated based on the currently available data. For example, a compressor might function by recognizing repeated character patterns in a data stream and replacing these repeated patterns with a shorter code sequence to represent that pattern. As long as the compressor and decompressor agree on what these code sequences are then the decompressor can always recreate the original data from the compressed data.

This mapping of sequences in the original data to corresponding sequences in the compressed output is commonly called a ***data dictionary***. These dictionaries may be statically defined - experienced-based information available to the compressor and decompressor - or they may be dynamically generated, usually based on the information being compressed. Static dictionaries are most applicable to environments where the data being processed is of a limited, known nature, and not very effective for general-purpose compressors. Most compression systems use dynamic dictionaries, including any compressors used on the device. On a 2212 the data dictionaries are based on the current packet being processed and possibly previously seen packets, but there is no ability to "look ahead" in the data stream as may exist when compression is performed at other layers. For systems where the data dictionary is dynamically derived and based only on previously seen data, the dictionary is also commonly known as a ***history***. The terms history and data dictionary will be used interchangeably throughout the remainder of this chapter, though it should be understood that in other environments a history is a specific form of data dictionary.

The fact that the device uses dynamic dictionaries and that the compressor and decompressor must keep their dictionaries in synchronization means that data compression works on a stream of data passing between two endpoints. Hence, compression on the router is a connection-oriented process, where the endpoints of the connection are the compressor and decompressor themselves. When compression is started on the stream, both ends reset their data dictionaries to some known starting state, and then they update that state as data is received.

Compression could be performed on each individual packet, resetting the histories prior to processing each packet. Normally though, the data dictionaries are not reset between packets, which means that the histories are based not only on the

contents of the current packet, but also the contents of previously seen packets. This usually improves the overall compression effectiveness, because it increases the amount of data which the compressor searches looking for redundancy to remove. As an example, consider the case of one host “pinging” another host with IP: a series of packets is sent out, each one usually nearly identical to the last one sent. The compressor may have little luck compressing the first packet, but it may recognize that each subsequent packet looks very much like the last one sent, and produce highly compressed versions of those packets.

Because the compressor and decompressor histories change with each packet received, the compression mechanisms are sensitive to lost, corrupted, or reordered packets. The compression protocols employed by the device include signalling mechanisms whereby the compressor and decompressor can detect loss of synchronization and resynchronize to each other, such as might be necessary when a packet is lost due to a transmission error. Typically this is done by including a sequence number in each packet which the decompressor will check to make sure it is receiving all packets, in order. If it detects an error, it will reset itself to some known starting state, signal the compressor to do likewise, and then wait (discarding incoming compressed packets) until the compressor acknowledges that it has also reset itself.

Compression on a link typically is performed on data going in both directions over the link. Normally, each end of a connection has both a compressor and decompressor running on it, communicating with their analogs at the other end of the connection, as shown in Figure 9 on page 130. The output (compression) side runs independently of the input (decompression) side. It is possible for completely different compression algorithms to be operating for each direction of the link. When a link connection is established, the compression control protocol for the link will negotiate with the peer to determine the compression algorithm(s) used for the connection. If the two ends cannot agree on compression protocols to use, then no compression will be performed and the link will operate normally - packets will simply be sent in uncompressed form.

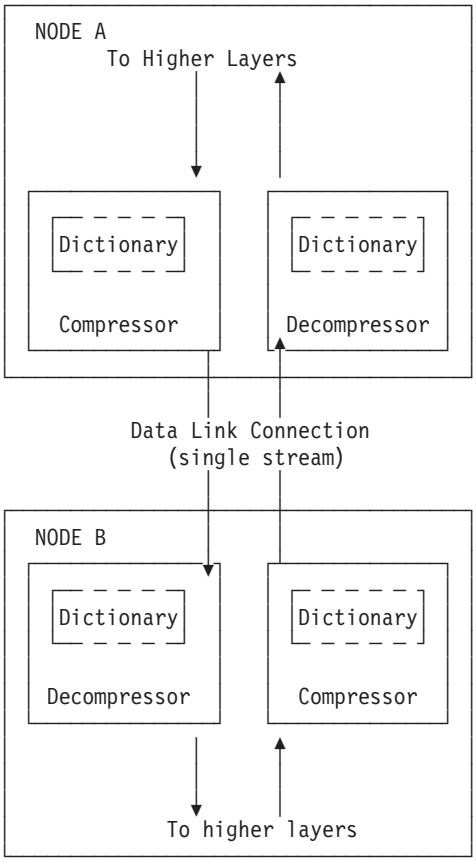


Figure 9. Example of Bidirectional Data Compression with Data Dictionaries

A stream really represents a connection between a specific compression process on one end of a link and an associated decompression process on the other end of a link, and thus is more specific than just a “connection” between two nodes; it is possible that a sophisticated compression protocol could split the data flowing between two hosts into multiple streams, compressing each of these streams independently. For example, PPP’s CCP has the ability to negotiate the use of multiple histories over a single PPP link, though the router does not support this.

Considerations

The choice of whether or not to use data compression is not always an easy one. There are several factors which should be considered before enabling compression on a connection.

CPU Load

Data compression is a computationally expensive procedure. As the amount of data being compressed increases (per unit time), the more of a load is put on the device’s processor. If the load becomes too great, the performance of the device degrades - on all network interfaces, not just the ones where compression is being performed.

The device actually contains multiple processors and uses asymmetric multiprocessing - for example, link I/O controllers which operate in tandem with the main processor - so the effect of the processor loading is not always readily

measured. Because the compression operation may be overlapped with the transmission of packets, this loading may in fact be totally transparent and pose no problem. Nonetheless, it is possible to overburden the device's processor and degrade performance.

As a general rule of thumb, compression should only be enabled on slow speed WAN links - probably only for links with speeds up to about 64 kilobits per second (the speed of a typical ISDN dial link). The total bandwidth for data being compressed on all links probably should be limited to several hundred kilobits per second. Running compression on all channels of an ISDN Primary Rate adaptor would be unwise.

Some of the device configuration parameters allow you to limit the number of connections which may be concurrently running compression. More interfaces can be enabled for compression then than are actually running it. Once the limit on the number of active compression connections is reached, additional connections will simply not negotiate the use of compression, at least not until an existing compression link shuts down.

Memory Usage

Another issue to consider when configuring compression is the memory requirement. Compression and decompression histories occupy a fair amount of memory, which is a limited resource in the device. The Stac-LZS algorithm for example requires about 16 Kbytes for a compression history, and about 8 Kbytes for a decompression history. This problem is magnified by the fact that these histories must exist for each connection which is established: a compression history is synchronized with a corresponding decompression history in a peer router. For a PPP link, this implies one compression history and one decompression history (assuming that data compression is running bidirectionally on the link). On a Frame Relay link, there could be many such histories required, one pair for each virtual connection (DLCI) which is established.

The device allocates a limited number of compression and decompression histories when it boots. These are always allocated in pairs known as ***compression contexts*** - a context is simply one compression history coupled with one decompression history. Technically, compression and decompression are independent functions and the allocation of compression and decompression histories could be performed independently; however, in practice compression is almost always run bidirectionally and so memory is managed and configured in terms of contexts rather than individual histories as a way of simplifying operation. Each context is allocated 24 Kbytes which includes the memory required for compression and decompression histories.

Whenever the device attempts to establish a compression connection on a link, it begins by reserving a context from the allocated pool of contexts. If no contexts are available, then compression is not performed on that connection. The router may attempt to start compression on that connection later as contexts become available.

The number of compression contexts which are allocated is a configurable parameter. Setting the number of contexts allocated limits both the amount of memory used and the maximum number of connections which may be simultaneously operating with compression. Limiting the number of simultaneously operating compression connections provides a means to help control the CPU loading problem.

Data Content

The actual nature of the data being transmitted on a connection should be considered before enabling compression for that connection. Compression works better on some types of data than others. Packets which contain a lot of nearly identical information - for example a set of packets generated from an IP “ping” - will normally compress extremely well. A typical assortment of random text and binary data going over a link will usually compress in ratios around 1.5:1 to 3:1. Some data simply will not compress well at all. In particular, data which has already been compressed will seldom compress further. In fact, data which has been previously compressed may actually expand when fed through the compression engine.

If it is known in advance that most of the data flowing over a connection will consist of compressed data, then it is recommended that compression not be enabled for that connection. An example where this might occur is a connection to a host which was set up to be primarily a FTP file archive site, where all the files available to be transferred are stored in compressed form on the host.

Link Layer Compression

A final factor to consider is the nature of the network link between the two hosts. Compression could be performed at a lower layer than even the device’s hardware interfaces. In particular, many modern modems incorporate data compression mechanisms in their hardware and firmware. If compression is being performed on the link at a lower layer (outside the device), then it is best not to enable data compression on the device for that interface. As already mentioned, compressing an already compressed data stream is normally ineffective, and in fact may degrade performance slightly. Unless there is some particular reason to believe that the router will do a much better job of compression than the link hardware, it is best to let the link hardware do the compression.

Using Data Compression on PPP Links

The 2212 uses the PPP Compression Control Protocol (CCP) to negotiate the use of compression on a link. CCP provides a generalized mechanism to negotiate the use of a particular compression protocol, possibly even using a different protocol in each direction of the link, and various protocol-specific options. The software supports the Stac-LZS and MPPC protocols, so the peer must also provide support for at least one of these algorithms to successfully negotiate data compression between the two nodes. The two nodes must also agree on the algorithm-specific options for compression to operate.

Configuring Data Compression on PPP Links

To configure data compression on PPP links:

1. Enable the CCP protocol on the link with the **enable ccp** command. This enables the link to negotiate compression with the other node. Negotiation includes what compression protocol to use and any protocol-specific options.
2. Select which compression protocols may be negotiated using the **set ccp protocols** command.
3. Set the negotiable parameters for each compression protocol using the **set ccp options** command.

You can display the current compression configuration using the **list ccp** command.

Table 16 lists the available commands and Figure 10 is an example of configuring compression on a PPP link. For detailed descriptions of these commands, see 'Point-to-Point Configuration Commands' in *Access Integration Services Software User's Guide*.

Table 16. PPP Data Compression Configuration Commands

Data Compression Command	Action
disable ccp	Disables data compression.
enable ccp	Enables data compression.
set ccp options	Sets options for the compression algorithm.
set ccp algorithms	Specifies a prioritized list of compression protocols.
list ccp	Displays compression configuration.

```
Config> network 1
Point-to-Point user configuration
PPP Config> enable ccp
PPP Config> set ccp options
STAC: # histories [1]? 1
STAC: check mode (0=none, 1=LCB, 2=CRC, 3=Seq, 4=Ext) [3]? 3
PPP Config> list ccp
CCP Options
-----------

Data Compression enabled
Algorithm list: STAC-LZS
Stac: histories 1
Stac: check_mode SEQ
```

Figure 10. Example of Configuring Compression on a PPP Link

Notes:

1. The network command selects the network interface for the PPP link. If the link is a PPP dial circuit, you must then use the **encapsulator** command to access the PPP configuration menu.
2. If you enable CCP and do not set protocols for the link, the software automatically sets the link to use protocols STAC and MPPC as if you had entered the command **set ccp protocols stac mppc**.

   If you set multiple protocols, the order of the protocols determines the negotiation preference for the link.
3. If you enter **set ccp protocols none**, the software will automatically disable compression on the link.

The following example shows the output of the talk 5 **list ccp** command when Microsoft Point-to-Point Encryption (MPPE) has been configured. Configuring MPPE enables MPPC compression. See the chapter "Configuring and Monitoring Point to Point Protocol Interfaces" in the *Access Integration Services Software User's Guide* for instructions about configuring MPPE.

```
PPP> list ccp
CCP Options
-----------

Data Compression : Enabled
Algorithm list : MPPC
STAC histories : 1
STAC check_mode : SEQ

MPPE Options
------------
```

```
MPPE enabled
Mandatory encryption
Key generation : STATEFUL
```

Monitoring Compression on PPP Links

You monitor compression as you would other PPP components. ‘Accessing the Interface Monitoring Process’ in *Access Integration Services Software User’s Guide* describes how to access the PPP console environment and details about the commands. Table 17 lists the compression-related commands. Figure 11 shows an example of listing compression on a PPP interface.

Table 17. PPP Data Compression Monitoring Commands

Command	Function
list control ccp	Lists CCP state and negotiated options.
list ccp	Lists CCP packet statistics.
list cdp or **list compression**	Lists compressed datagram statistics.

```
+ network 1
PPP > list control ccp

CCP State:                Open
Previous State:           Ack Sent
Time Since Change:        2 minutes and 52 seconds

Compressor:   STAC-LZS histories 1, check_mode SEQ
Decompressor: STAC-LZS histories 1, check_mode SEQ
MPPE:         Not negotiated

PPP > list ccp

CCP Statistic             In                        Out
-------------             --                        ---

Packets:                  2                         3
Octets:                   18                        27
Reset Reqs:               0                         0
Reset Acks:               0                         0
Prot Rejects:             1                         -

PPP > list cdp

Compression Statistic     In                        Out
---------------------     --                        ---

Packets:                  19541                     19542
Octets:                   2550673                   2740593
Compressed Octets:        821671                    899446
Incompressible Packets:   0                         0
Discarded Packets:        0                         -
Prot Rejects:             0                         -
Compression Ratios:       3.11                      3.24
```

Figure 11. Monitoring Compression on a PPP Interface

Using Data Compression on Frame Relay Links

After configuring the global compression parameters and enabling compression on the interface, you must then set the parameters for each individual circuit (PVC) on the Frame Relay interface. Each circuit defined for the interface may have compression enabled on the circuit, and each circuit which successfully negotiates the use of compression uses one compression context from the global pool. You can also disable compression on the interface which means none of the circuits on that interface will be eligible to carry compressed data traffic.

Configuring Data Compression on Frame Relay Links

To configure data compression on FR links:

1. Enable compression on the interface using the **enable compression** command. This enables the link to negotiate compression with the other node.
2. Enable compression on each new PVC that will carry compressed data with the **add permanent-virtual-circuit** command. You can change existing PVCs using the **change permanent-virtual-circuit** command.

You can display the current compression configuration using the **list lmi** or **list permanent-virtual-circuit** commands.

Table 18 on page 136 lists the commands available for configuring compression on a Frame Relay link and Figure 12 on page 136 is an example of configuring a Frame Relay Link. See ‘Frame Relay Configuration Commands’ in *Access Integration Services Software User’s Guide* for details.

```
Config> net 2

Frame Relay user configuration

FR Config> enable compression
Maximum number of run-time compression PVCs (zero means no limit) [0]? 0
Do you want orphan PVCs to perform compression [Y]? n
The number of currently defined non-compression PVCs is 4
Would you like to change them all to compression PVCs [N]? y

FR Config> add perm

Circuit number [16]? 22
Committed Information Rate (CIR) in bps [65536]?
Committed Burst Size (Bc) in bits [64000]?
Excess Burst Size (Be) in bits [0]?
Assign circuit name []? cir22
Is circuit required for interface operation [N]?
Do you want to have data compression performed [Y]?

FR Config>list lmi

                        Frame Relay Configuration


  LMI enabled            =      No  LMI DLCI                       =       0
  LMI type               =    ANSI  LMI Orphans OK                 =     Yes
  CLLM enabled           =      No  Timer Ty seconds               =      11

  Protocol broadcast     =     Yes  Congestion monitoring          =     Yes
  Emulate multicast      =     Yes  CIR monitoring                 =      No
  Notify FECN source     =      No  Throttle transmit on FECN      =      No

  Data compression       =     Yes  Orphan compression             =      No
  Compression PVC limit  =    None  Number of compression PVCs     =       2

  PVCs P1 allowed        =      64  Interface down if no PVCs      =      No
  Timer T1 seconds       =      10  Counter N1 increments          =       6
  LMI N2 error threshold =       3  LMI N3 error threshold window =       4
  MIR % of CIR           =      25  IR % Increment                 =      12
  IR % Decrement         =      25  DECnet length field           =      No
  Default CIR            =   65536  Default Burst Size            =   64000
  Default Excess Burst   =       0

FR Config>list perm

  Maximum PVCs allowable =      64
  Total PVCs configured  =       2

             Circuit                Circuit   Circuit     CIR    Burst  Excess
              Name                  Number     Type      in bps  Size   Burst
---------------------------------- ------- ----------- ------- ------- -----
 circ16                              16    @ Permanent   65536   64000       0
 cir22                               22    @ Permanent   65536   64000       0

* = circuit is required
# = circuit is required and belongs to a required PVC group
@ = circuit is data compression capable
```

Figure 12. Example of Configuring Compression on a Frame Relay Link

Table 18. Data Compression Configuration Commands

Command	Action
add permanent-virtual-circuit #	Use to enable data compression on a specific PVC defined on an interface.
change permanent-virtual-circuit #	Use to change whether a specific PVC will compress data.
disable compression	Disables data compression.
enable compression	Enables data compression.
list lmi	Displays the current configuration of the interface.
list permanent	Lists summary information about circuits.

Note: Enabling compression on orphan circuits will decrease the number of available compression contexts available for the native PVCs on the device.

If you enable compression on a Frame Relay interface that already has compression enabled, the software asks you if you want to change compression parameters on the interface, as shown in the following example. You can change compression on the interface without disabling compression.

```
Example of changing compression on Frame Relay Interfaces
Config> net 2

Frame Relay user configuration

FR Config> enable compression
Data compression already enabled.
Do you wish to continue and change an interface parameter [Y]
Maximum number of run-time compression PVCs (zero means no limit) [0]? 32
Do you want orphan circuits to perform compression []?
Do you want to change the compression capability of all of your existing PVCs [N]?
```

Monitoring Data Compression on Frame Relay Links

You monitor compression as you would other Frame Relay components. Frame Relay Monitoring Commands in *Access Integration Services Software User's Guide* describes how to access the Frame Relay console environment and details about the commands. Table 19 lists the compression-related commands. "Monitoring Compression on a Frame Relay Interface or Circuit Example" shows an example of listing compression on a Frame Relay interface.

Table 19. Frame Relay Data Compression Monitoring Commands

Command	Display
list lmi	Lists the current status of the interface.
list permanent	Lists summary information about circuits.
list circuit	Lists the current status of a circuit.

Monitoring Compression on a Frame Relay Interface or Circuit Example

```
+ network 2
FR 2 > list lmi

Management Status:
  ------------------

    LMI enabled          =      No  LMI DLCI                   =       0
    LMI type             =    ANSI  LMI Orphans OK             =     Yes
    CLLM enabled         =      No

    Protocol broadcast   =     Yes  Congestion monitoring      =     Yes
    Emulate multicast    =     Yes  CIR monitoring             =      No
    Notify FECN source   =      No  Throttle transmit on FECN  =      No
    PVCs P1 allowed      =      64  Interface down if no PVCs  =      No
    Line speed (bps)     =   64000  Maximum frame size         =    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          =   65536  Default Burst Size         =   64000
    Default Excess Burst =       0

    Current receive sequence  =       0
    Current transmit sequence =       0
    Total status enquiries    =       0  Total status responses   =       0
    Total sequence requests   =       0  Total responses          =       0

    Data compression enabled  =     Yes  Orphan Compression       =      No

    Compression PVC limit     =    None  Active compression PVCs  =       1
```

```
 PVC Status:
 -----------

   Total allowed  =      64  Total configured  =       1
   Total active   =       1  Total congested   =       0
   Total left net =       0  Total join net    =       0


FR 2 > list permanent

 Circuit                                  Orphan  Type/   Frames      Frames
 Number            Circuit Name           Circuit State Transmitted  Received
 ------- -------------------------------- ------- ----- ----------- --------

     16  circ16                             No   @ P/A        58364      58355
     22  circ22                             No   & P/A        58364      58355

    A - Active   I - Inactive   R - Removed   P - Permanent   C - Congested
    * - Required               # - Required and belongs to a PVC group
    @ - Data compression capable but not operational
    & - Data compression capable and operational

FR 2 > list circuit 22

 Circuit name = circ22

     Circuit state        =    Active  Circuit is orphan   =           No
     Frames transmitted   =     58391  Bytes transmitted   =      2676894
     Frames received      =     58383  Bytes received      =      2671009
     Total FECNs          =         0  Total BECNs         =            0
     Times congested      =         0  Times Inactive      =            0
     CIR in bits/second   =     65536  Potential Info Rate =        64000
     Committed Burst (Bc) =     64000  Excess Burst (Be)   =            0
     Minimum Info Rate    =     16000  Maximum Info Rate   =        64000
     Required             =        No  PVC group name      =   Unassigned

     Compression capable  =       Yes  Operational         =          Yes
     R-R's received       =         0  R-R's transmitted   =            0
     R-A's received       =         0  R-A's transmitted   =            0
     R-R mode discards    =         0  Enlarged frames     =            0
     Decompress discards  =         0  Compression errors  =            0
     Rcv error discards   =         0

     Compression ratio    =  1.00 to 1  Decompression ratio =    1.00 to 1

     Current number of xmit frames queued                  =            0
     Xmit frames dropped due to queue overflow             =            0
```

Chapter 11. Configuring and Monitoring Data Compression

Configuring data compression on a 2212 is a two-step process. The core compression system is a “Feature” in the software. You set and monitor global parameters by selecting the CMPRS feature in the Configuration and Monitoring tasks (the GWCON and CONFIG processes in the router). In addition to configuring the global parameters, you must also configure compression for each network interface (PPP or Frame Relay) on which you will transmit compressed data traffic.

This section describes configuring and monitoring the compression feature first and then describes configuring and monitoring compression on PPP and Frame Relay interfaces.

Configuring the Compression Feature

The only configurable parameter for the compression feature is the number of compression contexts to allocate when the device boots. The number of available contexts limits the number of connections that can be active simultaneously, as well as determining the amount of memory set aside for compression histories. Setting the number of contexts to zero disables compression on all interfaces.

In the Config process, enter **feature cmprs** at the `Config >` prompt to access the compression configuration commands. To change the number of contexts allocated, use the **SET MAXCONTEXTS *n*** command where ***n*** is the number of contexts. To see the current configuration, use the **list** command. The complete set of configuration commands is summarized in Table 20, and a configuration example is shown in Figure 13.

```
Config> feature cmprs

Data Compression Global Configuration
CMPRS Config> ?
LIST
SET
EXIT

CMPRS Config> set ?
MAXCONTEXTS

CMPRS Config> set maxcontexts
Number of compression contexts to allocate? (0 - 1000) [0]? 10

CMPRS Config> list
Number of compression contexts to allocate: 10
```

Figure 13. Configuring the Compression Feature

Table 20. Compression Configuration Commands

Command	Action
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvi.
List	Displays the current setting of maxcontexts.
Set	Sets the maximum number of compression contexts available for all interfaces.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

List

Use the **list** command to display the current setting of *maxcontexts*.

Syntax:

list

Set

Use the **set** command to set the maximum number of interfaces that can use data compression simultaneously.

Syntax:

set maxcontexts *n*

maxcontexts *n*

Sets the maximum number of compression contexts available for the interfaces. This parameter causes the device to allocate a pool of memory for compression contexts. Setting maxcontexts to 0 prevents any interface from compressing data even if you enabled compression on the interface.

Note: Setting this value too high can result in excessive memory use and decreased throughput for the device.

Default Value: 0

Valid Values: 0 to 1000

Example: `set maxcontexts`

```
Number of compression contexts to allocate? (0-1000)? [0]? 10
```

Monitoring the Compression Feature

In the monitoring process, enter **feature cmprs** at the + prompt to access the compression monitoring commands. Table 21 lists the available commands.

Table 21. Compression Monitoring Command

Command	Action
? (Help)	Displays all the commands available for this command level or lists the options for specific commands (if available). See “Getting Help” on page xxvi.
List	List either the memory or contexts in use.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

List

Use the **list** command to list either the memory or the contexts currently in use.

Syntax:

list all

contexts usage

memory usage

all Displays the contexts in use and the interfaces using the contexts, and the memory usage statistics. The output is a combination of list contexts usage and list memory usage displays.

Example: `list all`

context usage
Displays all of the compression contexts currently allocated by an interface. This display allows you to see which interfaces are currently compressing data traffic

Example: `list context usage`

```
Compression System Context (Data Dictionary) Usage
--------------------------------------------------

    CTX  Net Interface   Channel   Status
    ---  --- ----------  --------- -------------------
      0    2  FR/0              16 In use
      1    1  PPP/0              1 In use

Total: 10     Free: 8     In Use/Reserved: 2
```

CTX This is the context number, which is an identifying tag for the context. The device creates a pool of contexts when it boots, and assigns a number to each context in the pool. The context number is also displayed in some of the compression-related ELS messages.

Net This is the number of the network interface which has allocated a particular context.

Interface
This is the name of the network interface.

Channel
The channel is an identifier used to distinguish between multiple contexts allocated to the same network interface. The network number and channel number together uniquely identify a single compression stream. For PPP links, only a single compressed data stream runs on the link, and this number will always be 1. For Frame Relay links, this number is the virtual circuit number (DLCI) of the particular circuit that is carrying compressed traffic.

Status
This field indicates the current status of the context, which will almost always be “In use”. Occasionally “Defunct” may appear which indicates that compression has been shut down on a link, but that the context has not yet been released to the pool for reuse.

memory usage
Displays basic statistics about the current state of the compression feature. The output shows the number of compression contexts which have been allocated, the number of contexts currently in use, the amount of memory required by a context, and the total amount of memory reserved for compression contexts.

Example:

```
list memory usage

Compression System Memory Usage Statistics
------------------------------------------

Number of contexts allocated:           0 *        in use: 0
Size of compression context:            24624
   = Max compression history size:      16396
```

```
   + Max decompression history size:     8200
   + Overhead:                           28
Total memory allocated for contexts:     0

* Compression is disabled due to inability to allocate
  the requested number of contexts (500).
```

Chapter 12. Using Local or Remote Authentication

Authentication is the process of determining who a user (or entity) is. Authenticating user access for the PPP protocol on the 2212 extends the flexibility of user profile management as it relates to PPP authentication protocols PAP, MSCHAP, CHAP, and SPAP. See 'PPP Authentication Protocols' in *Access Integration Services Software User's Guide* for additional information about configuring PAP, MSCHAP, CHAP, and SPAP.

Authentication can be configured locally or can be configured to consolidate user configuration using authentication servers that are available on the network to service authentication requests for the entire network. The IBM 2212 implements locally maintained authentication as well as the following authentication server protocols:

- Radius
- TACACS
- TACACS+

Using Authentication, Authorization, and Accounting (AAA) Security

Authentication, Authorization, and Accounting (AAA) Security are configurable protocols that allow you to control access to your services. You can configure AAA to perform for local or remote authentication.

You can configure a security protocol for three types of functions.

- PPP links
- Login users (Telnet/Console Login)
- Tunnels

The configuring is done by setting a primary and secondary server. The server information is configured and stored separately from the AAA configuration. You use a server profile by a name that is provided at configuration time.

Under all circumstances accounting cannot be done locally and must be either Radius or TACACS+.

Authorization can only be done locally, or through remote authentication that uses Radius or TACACS+.

What is AAA Security?

AAA Security is the name of the security system for this device. It includes:

Authentication
: The process of identifying a user. Authentication utilizes a name and a password for access.

Authorization
: The process of determining the services to which a user is allowed access. Authorization processing might find that the user is not authenticated. The authorization agent then determines whether an unauthenticated user is allowed access to the services in question.

Accounting
The process of recording when a user has started or stopped a session. There are two types of accounting records supported.

Start records
Indicates that a service is about to begin.

Stop records
Indicates that a service has ended.

Using PPP

For the Point-to-Point Protocol (PPP) you can configure the following:

- Authentication
- Authorization
- Accounting

Each function can have its own security protocol that you configure independently.

- Setting the authentication protocol will have no effect on authorization or accounting.
- Setting the authorization protocol will have no effect on authentication or accounting.
- Setting the accounting protocol will have no effect on authentication or authorization.
- Setting AAA to remote will set authentication to remote, authorization to remote and set accounting to remote.
- Setting AAA to local will set authentication to local, authorization to local, and set accounting to ignore. You cannot disable authentication or authorization.

See Point-to-Point Configuration Commands in *Access Integration Services Software User's Guide* for details about the PPP configuration commands that you use in this environment.

Valid PPP Security Protocols

The following are valid PPP security protocols:

Authentication Methods
Local, RADIUS, TACACS+, TACACS

Authorization Methods
Local, RADIUS, TACACS+

Accounting Methods
RADIUS, TACACS+

Table 22. Set PPP Security Protocols

Action	Authent	Author	Acct
set AAA local	local	local	ignore
set AAA remote	remote	remote	remote
set AUTHENT local	local	ignore	ignore
set AUTHOR local	ignore	local	ignore
set AUTHENT remote	remote	ignore	ignore
set ACCOUNTING local	n/a	n/a	n/a

Table 22. Set PPP Security Protocols (continued)

Action	Authent	Author	Acct
set AUTHOR remote	ignore	remote	ignore
set ACCOUNTING remote	ignore	ignore	remote
disable ACCOUNTING	ignore	ignore	disabled
disable AUTHENT	n/a	n/a	n/a
disable AUTHOR	n/a	n/a	n/a

Using Login

For AAA login configuration, either remote or local can be selected. If local authentication is desired, then Local authorization must also be used. If remote authentication is selected, then, remote authorization must be used. accounting is not supported locally, so when authenticating and authorizing locally you must disable accounting.

Attention: Before enabling console login, save the configuration with console login disabled. If login authentication is set to a remote server using Radius, TACACS, or TACACS+ and the router is unable to reach the authentication server, then access to the router is denied. Disabling the console login prevents a lockout situation.

When configuring remote authentication, you can set authorization to another remote authorization protocol Radius or TACACS+, and set accounting to use Radius or TACACS+.

- Setting AAA to local sets authentication to local, authorization to local, and accounting to disabled.
- Setting AAA to remote sets authentication to remote, authorization to remote, and accounting to remote.
- Setting the authentication protocol to local automatically sets the authorization protocol to the same and disables accounting.
- Setting the authentication protocol to remote automatically sets the authorization protocol to the same only if the authorization protocol is set to local and ignores the accounting protocol.
- Setting the authorization protocol to remote automatically sets the authentication protocol to the same only if the authentication protocol is set to local and ignores the accounting protocol.
- Setting the accounting protocol to remote automatically sets authentication protocol to same only if the authentication protocol is set to local, and sets the authorization protocol to the same only if authorization is set to local.
- Setting the accounting protocol to disable has no effect on the authentication or authorization protocol.
- Disabling authentication or authorization is not allowed.

Valid Login/Admin Security Protocols

The following are valid Login/Admin security protocols.

Authentication/Authorization Methods
Local, RADIUS, TACACS Plus

Using Local or Remote Authentication

Accounting Methods
RADIUS, TACACS Plus

Table 23. Set Login Security Protocols

Action	Authent	Author	Acct
set AAA local	local	local	disabled
set AAA remote	remote	remote	remote
set AUTHENT local	local	local	disabled
set AUTHOR local	local	local	disabled
set AUTHENT remote	remote	remote, if local else ignore	ignore
set AUTHOR remote	remote, if local else ignore	remote	ignore
set ACCOUNTING remote	remote, if local else ignore	remote, if local else ignore	remote
disable ACCOUNTING	ignore	ignore	disabled
disable AUTHEN	n/a	a	n/a
disable AUTHOR	n/a	n/a	n/a

Using Tunnels

Set tunnel authentication the same as tunnel authorization. When you set tunnel authentication to either local or remote, you can then enable accounting. The tunnel authorization and authentication server must be the same.

Valid Tunnel Security Protocols

The following are valid Tunnel security protocols:

Authentication/Authorization Methods
Local, RADIUS

Accounting Methods
RADIUS, TACACS Plus

Table 24. Set Tunnel Security Protocols

Action	Authent	Author	Acct
set AAA local	local	local	ignore
set AAA remote	remote	remote	remote
set AUTHENT local	local	local	ignore
set Author local	local	local	ignore
set AUTHENT remote	remote	remote	ignore
set AUTHOR remote	remote	remote	ignore
set ACCOUNTING remote	ignore	ignore	remote
disable ACCOUNTING	ignore	ignore	disabled
disable AUTHENT	n/a	n/a	n/a
disable AUTHOR	n/a	n/a	n/a

Password rules

Local authentication allows you to use a password to control login access. The password can be checked against any or all of the following rules.

- Be a minimum number of characters in length. You set the number of characters required.
- Contain at least one alphabetic character.
- Contain at least one non-alphabetic character.
- Contain a non-numeric character in the first position.
- Contain a non-numeric character in the last position.
- Contain no more than three identical consecutive characters that were used in the previous password.
- Contain no more than two consecutive characters.
- Not contain the userid as a part of the password.
- Not the same as any of the previous three passwords.
- Be changed after a certain number of days. You set the number of days between password changes.

Understanding Authentication Servers

An ***authentication server*** is a server in the network that validates userids and passwords for the network. If a device is configured for authentication through an authentication server and the device receives a packet from an authentication protocol, the device passes a userid and password to the server for authentication. If the userid and password are correct, the server responds positively. The device can then communicate with the originator of the request. If the server does not find the userid and password that it receives from the device, it responds negatively to the device. The device then rejects the session from which it got the authentication request.

SecurID Support

The 2212 can authenticate dial-in clients that use SecurID with a Security Dynamics ACE/Server. This support uses TACACS, TACACS+, or RADIUS on the ACE/Server for authentication of the client. Configure the dial-in client the same as other dial-in clients on the 2212.

The dial-in client logs on as usual, but uses the SecurID passcode for the password. The SecurID passcode consists of a 4 to n-digit PIN number that is followed by the number from the SecurID token card. (The maximum number of digits in the PIN depends on the server.) The userid and password could appear as:

```
Username: John Customer

Password: 1234098765
```

Figure 14. SecurID Username and Passcode

Using Local or Remote Authentication

When the ACE/Server authenticates the logon, it may request the next token from the client. The next token is the next token on the token card. The maximum number of digits in the next token depends on the SecurID token card the client is using. The client can enter the passcode and the next token when prompted for the password by using the format `passcode*token` as in the following:

```
Username: John Customer

Password: 1234098765*111111
```

Figure 15. SecurID Passcode with Next Token

Note: When the server requests the client to enter the next token, the client must:

1. Enter the PIN
2. Wait for a new token from the card and enter that token
3. Enter * followed by the next token from the card

The ACE/Server administrator configures the conditions that cause the server to request the next token or new PIN.

The dial-in clients should use SPAP so they can receive alerts from the authentication system when they need to enter the next token. If the client is not using SPAP and they are not successful logging on, they should try entering a new passcode using the `passcode*token` format. If the client is still not successful, there could be other problems between the client and the ACE/Server.

Limitations

The following limitations exist:

- Security Dynamics Inc. (SDI) and DES encryption are not supported.
- The SecurID “New PIN” function is not supported.
- TACACS does not support the “New PIN” or “Next-Token” functions. The client can specify a next-token when logging in, but the server will not use it.
- Clients configured for callback are not supported.
- When using CHAP with TACACS or TACACS+, set the CHAP rechallenge interval to 0.
- Do not use CHAP when using RADIUS authentication.
- Your clients can obtain the best results by using TACACS+ and SPAP.
- Windows 3.1 DIALs client with SecurID authentication using multilink is not supported.
- When using SecurID authentication, it is highly recommended to use the latest client software (for example, Windows 95 or OS/2).

Chapter 13. Configuring Authentication

This chapter describes the configuration and operational commands for authentication. It includes the following sections:

- "Accessing the Authentication Configuration Prompt"
- "Authentication Configuration Commands"

Accessing the Authentication Configuration Prompt

To access the `Authent config >` prompt:

1. Enter **talk 6** at the `*` prompt.
2. Enter **feature auth** at the `Config >` prompt.

Authentication Configuration Commands

Table 25 lists the commands available at the `Authent config >` prompt.

Table 25. Authentication 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 xxvi.
Disable	Disables accounting for AAA.
List	Displays the AAA configuration parameters.
Login	Configures AAA for login.
Nets-info	Displays information about local PPP authentication.
Password-rules	Configures password rules (enables or disables).
PPP	Configures AAA for PPP.
Quickset	Configures the authentication method quickly.
Servers	Configures individual remote AAA servers.
Set	Configures Authentication parameters regardless of type.
Tunnel	Configures AAA for L2TP tunnels.
User-profile	Configures local PPP users.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Disable

Use the **disable** command to disable accounting.

Syntax:

disable accounting

List

Use the **list** command to display the AAA parameters.

Syntax:

list accounting

authentication

authorization

all

config

```
AAA Config> list all
ppp AAA configuration...
 ppp authentication        : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
   Key for encryption        <notSet>
 ppp authorization         : locallist
 ppp accounting            : Disabled
tunnel AAA configuration...
 tunnel authentication     : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
   Key for encryption        <notSet>
 tunnel authorization      : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
   Key for encryption        <notSet>
 tunnel accounting         : Disabled
login AAA configuration...
 login authentication      : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
   Key for encryption        <notSet>
 login authorization       : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
   Key for encryption        <notSet>
 login accounting          : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
   Key for encryption        <notSet>

AAA Config> list accounting all
accounting AAA configuration...
 accounting ppp            : Disabled
 accounting tunnel         : Disabled
 accounting login          : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
```

```
   Key for encryption        <notSet>
AAA Config> list accounting config
accounting ppp            : Disabled
accounting login          : Radius        serv01
accounting tunnel         : Disabled

AAA Config> list authentication all
authentication AAA configuration...
 authentication ppp        : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
   Key for encryption        <notSet>
 authentication tunnel     : Radius        serv01
   authorizeAuthent          YES
   Primary server address    1.1.1.1
   Secondary server address  2.2.2.2
     Request tries           3
     Request interval        3
   Key for encryption        <notSet>
```

Login

Use the **login** command to configure AAA for login.

Table 26 lists the subcommands available with the **login** command.

Table 26. Login Subcommands

Command	Function
Disable	Disables accounting for login.
List	Displays the AAA configuration parameters for login.
Set	Sets the AAA configuration parameters for login.

Disable

Use the **login disable** command to disable accounting.

Syntax:

login disable accounting

List

Use the **login list** command to display the AAA configuration parameters.

Syntax:

login list all
accounting
authentication
authorization
config

Set

Use the **login set** command to configure authentication parameters.

Syntax:

login set aaa
accounting
authentication
authorization

aaa *authtype*
Sets the authentication, authorization, and accounting type. *Authtype* is one of the following:

local Sets the authentication, authorization, and accounting type to use a locally-maintained user database.

remote
Sets the authentication, authorization, and accounting type to use a remote user database.

server id
Specifies the identifier of the remote database.

accounting *authtype*
Sets the accounting type. *Authtype* is one of the following:

remote
Sets the authentication type to use a remote user database.

server id
Specifies the identifier of the remote database.

authentication *authtype*
Sets the authentication type. *Authtype* is one of the following:

local Sets the authentication type to use a locally-maintained user database.

remote
Sets the authentication type to use a remote user database.

server id
Specifies the identifier of the remote database.

authorization *authtype*
Sets the authorization type. *Authtype* is one of the following:

local Sets the authorization type to use a locally-maintained user database.

remote
Sets the authorization type to use a remote user database.

server id
Specifies the identifier of the remote database.

Nets-info

Use the **nets-info** command to display the currently configured PPP authentication protocol on each PPP interface.

Syntax:

nets-info

Password-rules

Use the **password-rules** command to configure the password (enable or disable).

Table 27 lists the subcommands available with the **password-rules** command.

Table 27. Login Subcommands

Command	Function
Disable	Disables a password rule.
Enable	Enables a password rule.
List	Displays the current state of the password rules (enabled or disabled).

Disable

Use the **password-rules disable** command to disable any or all of the password rules.

Syntax:

password-rules disable all
compare-ident-prev
change-days
first-non-numeric
force-change
ident-chars
last-non-numeric
lockout
minimum-length
one-alpha
one-nonalpha
prev-three
userid-contained

compare-ident-prev
Compares the previous user identity with the user requesting a password change.

change-days
The maximum number of days before a password change is required.

Valid values: 0 to 360

Default value: 180

first_non-numeric
The first character of a password cannot be numeric.

Valid values: any non-numeric character

Default value: none

force-change
Forces a password change after the maximum change-days has expired. You are prompted for the old password, new password and to verify the new password.

Valid values: 0 to 360

Default value: 180

ident-chars
Cannot contain more than 3 characters used in a previous password in the same position.

last-non-numeric
The last character in the password cannot be numeric.

Valid values: any non-numeric character

Default value: none

lockout
The number of times you can try a password before you are locked out.

Valid values: 0 to 360

Default value: 3

minimum-length
The least number of characters required to have a valid password.

Valid values: 1 to 31

Default value: 8

maximum-length
The maximum number of characters a password can contain.

Valid values: 1 to 31

Default value: 8

one-alpha
At least one character in the password must be an alpha.

one-nonalpha
At least one character in the password must be numeric.

prev-three
The password cannot be the same as any of the last three passwords.

userid-contained
The password cannot contain the userid as a part of the password.

Enable

Use the **password-rules enable** command to enable any or all of the password rules. See the **disable** command for a list of password rule descriptions.

Syntax:

password-rules enable all
compare-ident-prev
change-days
first-non-numeric

force-change
ident-chars
last-non-numeric
lockout
minimum-length
one-alpha
one-nonalpha
prev-three
userid-contained

List

Use the **password-rules list** command to display the current state of the password rules (disabled or enabled).

Syntax:

password-rules list

PPP

Use the **ppp** command to configure AAA for PPP.

Table 28 lists the subcommands available with the **ppp** command.

Table 28. PPP Subcommands

Command	Function
Disable	Disables accounting for PPP.
List	Displays the AAA configuration parameters for PPP.
Set	Sets the AAA configuration parameters for PPP.

Disable

Use the **ppp disable** command to disable accounting for PPP.

Syntax:

ppp disable accounting

List

Use the **ppp list** command to display the AAA configuration parameters for PPP.

Syntax:

ppp list all
accounting
authentication
authorization
config

Set

Use the **ppp set** command to set the AAA configuration parameters for PPP.

Syntax:

ppp set aaa
accounting
authentication
authorization

aaa *authtype*
Sets the authentication, authorization, and accounting type. *Authtype* is one of the following:

local Sets the authentication, authorization, and accounting type to use a locally-maintained user database.

remote
Sets the authentication, authorization, and accounting type to use a remote user database.

server id
Specifies the identifier of the remote database.

accounting *authtype*
Sets the accounting type. *Authtype* is one of the following:

remote
Sets the authentication type to use a remote user database.

server id
Specifies the identifier of the remote database.

authentication *authtype*
Sets the authentication type. *Authtype* is one of the following:

local Sets the authentication type to use a locally-maintained user database.

remote
Sets the authentication type to use a remote user database.

server id
Specifies the identifier of the remote database.

authorization *authtype*
Sets the authorization type. *Authtype* is one of the following:

local Sets the authorization type to use a locally-maintained user database.

remote
Sets the authorization type to use a remote user database.

server id
Specifies the identifier of the remote database.

Servers

Use the **servers** command to configure individual remote AAA servers.

Table 29 lists the subcommands available with the **servers** command.

Table 29. Server Subcommands

Command	Function
Add	Adds a remote AAA server profile.
Change	Changes a remote server profile.
Delete	Deletes a remote server profile.
Lists	Displays the AAA server profile information.

Add

Use the **servers add** command to add a remote server profile.

Syntax:

servers add name

radius Sets the authentication type to use the radius authentication server protocol.

Values for the following parameters can be set:

key-for-encryption:
Specifies the encryption key.

Valid Values: Any alphanumeric character string up to 32 characters long.

Default Value: None.

primary-server-address:
Specifies the address of the primary authentication server.

Valid Values: Any valid IP address

Default Value: 0.0.0.0

retries

Valid Values: 1 to 100

Default Value: 3

retry-interval

Valid Values: 1 to 60

Default Value: 3

secondary-server-address:
Specifies the address of the secondary authentication server.

Valid Values: Any valid IP address

Default Value: 0.0.0.0

Author-Authent
Specifies whether authorization attributes are transferred during authentication.

Valid Values: yes, no

Default Value: yes

tacacs
Sets the authentication type to use the TACACS authentication server protocol.

Values for the following parameters can be set:

primary-server-address:
Specifies the address of the primary authentication server.

Valid Values: Any valid IP address

Default Value: 0.0.0.0

retries

Valid Values: 1 to 100

Default Value: 3

retry-interval

Valid Values: 1 to 60

Default Value: 3

secondary-server-address:
Specifies the address of the secondary authentication server.

Valid Values: Any valid IP address

Default Value: 0.0.0.0

tacacsplus
Sets the authentication type to use the TACACS+ authentication server protocol.

Values for the following parameters can be set:

encryption:
Specifies whether encryption will be used.

Valid Values: yes, no

Default Value:

key-for-encryption:
Specifies the encryption key to be used.

Valid Values: Any 16-hexadecimal digit value

Default Value:

primary-server-address:
Specifies the address of the primary authentication server.

Valid Values: Any valid IP address

Default Value: 0.0.0.0

privilege-level

Valid Values: 0 through 15

Default Value: 0

restarts
Sets the number of restarts. This parameter does not include timeout restarts and only pertains to restarts requested by the server.

Valid Values: 0 to 3200

Default Value: 0

time-to-connect
The amount of time to allow to obtain the authentication from the server.

Valid Values: 1 to 60

Default Value: 9

secondary-server-address:
Specifies the address of the secondary authentication server.

Valid Values: Any valid IP address

Default Value: 0.0.0.0

Change

Use the **servers change** command to change a remote server profile. See the **add** command for the remote server profile descriptions.

Syntax:

servers change	radius
	tacacs
	tacacsplus

See the **servers add** command for remote server profile descriptions.

Delete

Use the **servers delete** command to delete a remote server profile. See the **add** command for the remote server profile descriptions.

Syntax:

servers delete	radius
	tacacs
	tacacsplus

See the **servers add** command for the remote server profile descriptions.

List

Use the **servers list** command to display the AAA server profile information.

Syntax:

servers list	all
	names
	profile

Set

Use the **set** command to set the parameters for login, PPP, and L2TP tunnel.

Syntax:

set	aaa

accounting

authentication

authorization

aaa *authtype*
Sets the authentication, authorization, and accounting type. *Authtype* is one of the following:

local Sets the authentication, authorization, and accounting type to use a locally-maintained user database.

remote
Sets the authentication, authorization, and accounting type to use a remote user database.

server id
Specifies the identifier of the remote database.

accounting *authtype*
Sets the accounting type for login, PPP and tunnel. *Authtype* is one of the following:

remote
Sets the authentication type to use a remote user database.

server id
Specifies the identifier of the remote database.

authentication *authtype*
Sets the authentication type for login, PPP, tunnel. *Authtype* is one of the following:

local Sets the authentication type to use a locally-maintained user database.

remote
Sets the authentication type to use a remote user database.

server id
Specifies the identifier of the remote database.

authorization *authtype*
Sets the authorization type for login, PPP, and tunnel. *Authtype* is one of the following:

local Sets the authorization type to use a locally-maintained user database.

remote
Sets the authorization type to use a remote user database.

server id
Specifies the identifier of the remote database.

Tunnel

Use the **tunnel** command to configure AAA for L2TP tunnel.

Table 30 lists the subcommands available with the **tunnel** command.

Table 30. Tunnel Subcommands

Command	Function
Disable	Disables accounting for L2TP tunnel.
List	Displays AAA configuration parameters for L2TP tunnel.
Set	Sets the AAA configuration parameters for L2TP tunnel.

Disable

Use the **tunnel disable** command to disable accounting for L2TP tunnel.

Syntax:

tunnel disable accounting

List

Use the **tunnel list** command to display the AAA for L2TP tunnel.

Syntax:

tunnel list all
accounting
authentication
authorization
config

Set

Use the **tunnel set** command to set the AAA configuration parameters for L2TP tunnel.

Syntax:

tunnel set aaa
accounting
authentication
authorization

aaa *authtype*
Sets the authentication, authorization, and accounting type. *Authtype* is one of the following:

local Sets the authentication, authorization, and accounting type to use a locally-maintained user database.

remote
Sets the authentication, authorization, and accounting type to use a remote user database.

server id
Specifies the identifier of the remote database.

accounting *authtype*
Sets the accounting type. *Authtype* is one of the following:

remote
Sets the authentication type to use a remote user database.

server id
Specifies the identifier of the remote database.

authentication *authtype*
Sets the authentication type. *Authtype* is one of the following:

local Sets the authentication type to use a locally-maintained user database.

remote
Sets the authentication type to use a remote user database.

server id
Specifies the identifier of the remote database.

authorization *authtype*
Sets the authorization type. *Authtype* is one of the following:

local Sets the authorization type to use a locally-maintained user database.

remote
Sets the authorization type to use a remote user database.

server id
Specifies the identifier of the remote database.

User-profiles

Use the **user-profiles** command to access the `User profile config>` command prompt. From this prompt, you can access the following commands.

Table 31. User-profile 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 xxvi.
Add	Adds a PPP user profile.
Change	Changes a PPP user profile.
Delete	Deletes a PPP user profile.
Disable	Disables a PPP user profile.
Enable	Enables a PPP user profile.
List	Lists the PPP user profile information.
Report	Generates a PPP user profile report.
Reset-user	Resets a PPP user profile.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Add

Use the **user profiles add** command to add the user profile of a remote user to the local PPP user data base or to give a tunnel peer access through an IP network to the router.

Syntax:

add ppp-user

tunnel

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.

See Add in the chapter “Configuring the CONFIG Process” in *Access Integration Services Software User’s Guide* for a description of the command syntax and options.

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
```

tunnel 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.

See Add in the chapter “Configuring the CONFIG Process” in *Access Integration Services Software User’s Guide* for a description of the command syntax and options.

Example:

```
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
```

Change

Use the **change** command to change a user-profile.

Syntax:

change	ppp-user
	tunnel

Delete

Use the **delete** command to delete a user-profile.

Syntax:

delete	ppp-user
	tunnel

Disable

Use the **disable** command to disable a user-profile.

Syntax:

disable	*name*

Enable

Use the **enable** command to enable a user-profile.

Syntax:

enable	*name*

List

Use the **list** command to list user-profile information.

Syntax:

list	ppp-user
	tunnel

```
User profile config> list ppp-user
List  (Name, Verb, User, Addr, Encr, zdump): [Verb]
     PPP user name: ppp01
            Expiry: <unlimited>
   User IP address: Interface Default
        Encryption: Not Enabled
            Status: Enabled
    Login Attempts: 0
    Login Failures: 0
  Lockout Attempts: 0
1 record displayed.
```

List Specifies how to access the list information.

Valid values: name, verb, user, addr, encr, zdump

Default value: verb

PPP user name
Lists the user name.

Expiry
List the expiration date.

User IP address
List the users IP address.

Encryption
Lists whether encryption is enabled or not enabled.

Status
Lists whether status is enabled or not enabled

Login attempts
Lists the number of times the user has attempted to login.

Login failures
Lists the number of failed attempts to login.

Lockout attempts
Lists the number of lockout attempts.

Report

Use the **report** command to generate a PPP user profile report.

Syntax:

report

addresses
all
callback
dump
encrypt
name
password
time
user

```
User profile config> report addresses
PPP user name      User IP address
-----------------  -----------------
ppp01              Interface Default
1 record displayed.

User profile config> report all
     PPP user name: ppp01
            Expiry: <unlimited>
   User IP address: Interface Default
        Encryption: Not Enabled
            Status: Enabled
    Login Attempts: 0
```

```
    Login Failures: 0
  Lockout Attempts: 0
1 record displayed.

User profile config> report callback
PPP user name      Callback type        Phone Number
-----------------  -------------------  --------------------
ppp01
1 record displayed.

User profile config> report dump
Enter user name:  []? user01

User profile config> report encrypt
PPP user name      Encryption
-----------------  --------------
ppp01              Not Enabled
1 record displayed.

User profile config> report name
PPP user name
-----------------
ppp01
1 record displayed.

User profile config> report password
PPP user name      Expiry        Grace
-----------------  ------------  ------
ppp01              <unlimited>
1 record displayed.

User profile config> report time
PPP user name      Time alotted
-----------------  -------------------
ppp01
1 record displayed.

User profile config> report user
Enter user name:  []? login01
     PPP user name: login01
        Expiry: <unlimited>
   User IP address: Interface Default
        Encryption: Not Enabled
```

Reset-user

Use the **reset-user** command to reset a user-profile.

Syntax:

reset-user *name*

Chapter 14. Using and Configuring Encryption Protocols

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 *Access Integration Services Software User's Guide*.

The objective of encryption is to transform data into an unreadable form to ensure privacy. The ***encrypted*** data needs to be decrypted to get the original data.

The 221x supports:

- The RC4 encryption algorithm with 40 and 128 bit keys for Microsoft Point-to-Point Encryption (MPPE) on PPP interfaces.
- The Data Encryption Standard in Cipher Block Chaining Mode (DES-CBC) algorithm with 56-bit keys for PPP Encryption Control Protocol support as described in RCFs 1968 and 1969.
- The commercial Data Masking Facility (CDMF) which uses 40-bit keys for Frame Relay Encryption. This support is proprietary.

PPP Encryption Using Encryption Control Protocol

The Encryption Control Protocol (ECP) is used in the router to negotiate the use of encryption on the point-to-point links communicating using PPP protocol. The Encryption Control Protocol provides a generalized mechanism to negotiate which encryption and decryption algorithms will be used over a PPP link. Different encryption algorithms can be negotiated in each direction of the PPP link.

A method of encryption and decryption is called an ***encryption algorithm***. Encryption algorithms use a key to control encryption and decryption. Unlike compression, the router encrypts in both directions of the link, because encrypting in only one direction is a security risk. The link will be terminated whenever ECP cannot negotiate encryption algorithms in both directions.

Configuring ECP Encryption for PPP

To configure the device to use encryption at the data link layer, you should:

1. Set the encryption keys for remote devices and local PPP interfaces.

   Set the encryption key for the remote device using the **add ppp-user** command at the `Config>` prompt. See the Add command in the chapter "Configuring the CONFIG Process" in *Access Integration Services Software User's Guide* for a description of the command syntax and options.

   Set the encryption key for the local PPP interface using the **enable ecp** command (see the talk 6 `PPP Config>` **enable** command in the *Access Integration Services Software User's Guide*).
2. Configure individual PPP links to use Encryption Control Protocol (ECP) by using the **enable ecp** command at the `PPP Config>` prompt.
3. Enable PAP, CHAP, or SPAP.

You can also disable encryption, change the encryption key for a user, list the status of encryption, or set the name that the device uses when requesting encryption. For information about

- Disabling encryption, see the `PPP Config>` **disable ecp** command in the *Access Integration Services Software User's Guide*.

- Changing the remote user's encryption key and password, see the `Config>` **change ppp-user** command in the *Access Integration Services Software User's Guide*.
- Listing the encryption status, see the `PPP Config>` **list ecp** command in the *Access Integration Services Software User's Guide*.
- Setting the device's name, see the `PPP Config>` **set name** command in *Access Integration Services Software User's Guide*.

Monitoring ECP Encryption for PPP

You can monitor the various encryption settings on the interfaces by:

1. Accessing the monitoring prompt using the **talk 5** command.
2. Selecting the interface you want to monitor using the **network x** command. This command puts you at the `PPP x>` prompt.

From this prompt, you can:

- List the current state of encryption, the most recent encryption negotiation, the elapsed time since an encryption state change, and the algorithms in use by the encrypters. (See the **list control ecp** command in the *Access Integration Services Software User's Guide*.)
- List the encryption control packets received and transmitted on the interface. (See the **list ecp** command in the *Access Integration Services Software User's Guide*.)
- List the encrypted data packets transmitted or received on the interface. (see the **list edp** command in the *Access Integration Services Software User's Guide*.)

Microsoft Point-to-Point Encryption (MPPE)

Microsoft Point-to-Point Encryption (MPPE) provides a way for remotely-attached Windows workstations known as Microsoft Dial-Up Networking (DUN) clients to encrypt data that is transmitted over a PPP link between themselves and the 2212. MPPE can also be used to encrypt data being transmitted over a PPP link from router to router. MPPE is always negotiated in both directions.

MPPE uses secret key algorithms to perform encryption. In secret key algorithms, the same key is used for encryption and decryption. This key is not configured by the user, but is generated in the process of the negotiation of MPPE between the sending and the receiving workstations. To use MPPE, you must configure the authentication protocol Microsoft Challenge/Handshake Authentication Protocol (MS-CHAP).

If the PPP interface is authenticated with MS-CHAP, the router goes into a "Microsoft mode", in which it will negotiate only MPPC if compresssion is enabled and negotiate only MPPE if encryption is enabled. In "Microsoft mode", the router ignores the priority list of compression algorithms and disables ECP negotiation.

Configuring MPPE

To configure MPPE, you should perform these steps for each interface:

1. Configure MS-CHAP. In the *Access Integration Services Software User's Guide*, see "Microsoft PPP CHAP Authentication (MS-CHAP)" and "Configuring and Monitoring Point-to-Point Protocol Interfaces" for information about using and configuring MS-CHAP.

2. If you are configuring a router-to-router connection, set the name for the local PPP interface using the **set name** command (see the `PPP Config>` **set name** command in the *Access Integration Services Software User's Guide*).
3. If you want data compression, enable MPPC using the talk 6 **enable ccp** command at the `PPP Config>` prompt. MPPE does not require data compression.
4. Enable MPPE. Use the **enable mppe** command at the `PPP Config>` prompt (see the `PPP Config>` **enable** command in the *Access Integration Services Software User's Guide*).
5. Restart the router to activate the configuration.

You can also disable MPPE and list the MPPE options.

- Use the talk 6 **disable mppe** command at the `PPP Config>` prompt to disable MPPE.
- Use the talk 6 **list ccp** command at the `PPP Config>` prompt to list the MPPE options that have been configured.

Monitoring MPPE

Bring up the `PPP>` prompt as described in "Monitoring ECP Encryption for PPP" on page 168 . Use the **list mppe** command to see the MPPE data statistics and the **list control ccp** command to see the MPPE status. Examples of the outputs of these commands are displayed in "Configuring and Monitoring Point-to-Point Protocol Interfaces" in the *Access Integration Services Software User's Guide*.

Configuring Encryption on Frame Relay Interfaces

Note: Frame relay uses a proprietary encryption scheme.

Data encryption is supported on all interfaces on which you have enabled encryption. You can configure individual circuits on an encryption-enabled interface to perform or not perform encryption as desired.

To configure the device to use encryption on frame relay links:

1. Access the frame relay configuration prompt using the **talk 6** command.
2. Select the frame relay interface that you want to be encryption-capable using the **net** # command
3. Enable encryption on the frame relay interface using the **enable encryption** command. See the Frame Relay commands in the *Access Integration Services Software User's Guide*.
4. Add encryption—capable permanent virtual circuits and define the encryption key for each of the PVCs using the **add permanent-virtual-circuit** command. See the Frame Relay commands in the *Access Integration Services Software User's Guide*.
5. Repeat steps 1 through 4 for each encryption-capable interface you are configuring.

Note: If encryption is enabled for a FR permanent virtual circuit then data will not flow over the circuit unless encryption is successfully negotiated with the

device at the other end of the virtual circuit. Encryption is not supported for orphan circuits since you must configure the PVC in order to enter the encryption key.

You can also disable encryption for an interface, change the encryption settings for a PVC or list the status of encryption. For information about

- Disabling encryption on an interface, see the Frame Relay **disable encryption** command in the *Access Integration Services Software User's Guide*.
- Changing the encryption settings for a PVC, see the **change permanent-virtual-circuit** command in the *Access Integration Services Software User's Guide*.
- Listing the encryption status, see the Frame Relay **list all,**, **list lmi,** and the **list permanent-virtual-circuit** commands in the *Access Integration Services Software User's Guide*.

Monitoring Encryption on Frame Relay Interfaces

You can monitor the various encryption settings on the interfaces by:

1. Accessing the monitoring prompt using the **talk 5** command.
2. Selecting the interface you want to monitor using the **network** # command. This command puts you at the FR *x*> prompt.

From this prompt, you can list the current encryption state for an interface, a PVC, or a circuit. See the Frame Relay list monitoring commands in the *Access Integration Services Software User's Guide*.

Chapter 15. Using IP Security

Packets sent using the Internet Protocol (IP) can be made secure by using the IP Security feature of the 2212. This protection is provided by processes called authentication and encryption.

Note: In some countries, encryption support is not provided because of U.S. export regulations and the encryption parameters are not displayed. However, the ESP-NULL algorithm is always available. For a definition of the ESP-NULL algorithm, see "ESP Encryption Algorithms" on page 172.

Security, as defined by RFC 1825-Security Architecture for the Internet Protocol, consists of these properties:

Authentication
Knowing that the data received is the same as the data that was sent and that the claimed sender is, in fact, the actual sender.

Integrity
Ensuring that data is transmitted from source to destination without undetected alteration.

Confidentiality
Communicating in such a way that the intended recipients know what was being sent but unintended parties cannot determine what was sent.

Non-repudiation
Communicating so that the receiver can prove that the sender did, in fact, send certain data even though the sender might later deny ever having sent that data.

The IP Security feature of the 2212 provides three of these properties: authentication, integrity, and confidentiality. IP Security is supported in both IPv4 and in IPv6.

Secure Tunnels

To protect the data sent to another host, router, or firewall, you can configure a secure tunnel. An IP secure (IPsec) tunnel is a two-way logical connection to the remote host, router, or firewall over which protected IP packets are transmitted. The IP Authentication Header (AH) and the IP Encapsulation Security Payload (ESP) are techniques that use special IP headers with authentication and encryption to ensure the security of the tunnel.

A secure tunnel is identified by many parameters, such as the tunnel ID and the address of the destination host at the far end of the tunnel. IP security is created on the 2212 by manually configuring a secure tunnel for each IP route that must be made secure. Each set of parameters specified creates one secure tunnel.

Note: For each secure tunnel, the parameters in the following list must match at each end of the secure tunnel; that is, the sender and the receiver must be configured with the same value:

- AH algorithm and AH authentication keys (See "Configuring the Algorithms" on page 174.)

- ESP encryption algorithm and ESP encryption and decryption keys (See “Configuring the Algorithms” on page 174.)
- Security parameters indexes (SPIs) (See “Security Associations” on page 173 .)

IP Authentication Header (AH)

AH is described in draft-ietf-ipsec-auth-header-06 Authentication Header. This header holds authentication data for the IP datagram. The sender of the datagram uses a cryptographic authentication function that relies upon a secret authentication key. This cryptographic authentication function is applied to the contents of the datagram.

AH Authentication Algorithms

A secure tunnel that uses the AH tunnel policy must use one of these two authentication algorithms:

- HMAC-MD5 IP Authentication with Replay Prevention
- HMAC-SHA-1 IP Authentication with Replay Prevention

Both of these algorithms combine a keyed message authentication using cryptographic hash functions (abbreviated as HMAC) with replay prevention. Replay prevention, which is optional, uses a sequence number provided in the AH to verify that this packet has not been received before. Replay prevention is used to protect the receiver from denial-of-service attacks, where the same packets are repeatedly sent to the receiver. The router can become so busy processing the duplicate packets that it cannot process legitimate traffic. A sliding window is used to store enough sequence numbers to determine whether this sequence number has been received before.

IP Encapsulating Security Payload (ESP)

ESP is described in draft-ietf-ipsec-esp-v2-05 Encapsulating Security Payload. ESP encrypts part or all of the IP packet to give you confidentiality as well as authentication and integrity. In ESP, the authentication function is optional. If the ESP-NULL algorithm is selected, ESP performs no encryption, only authentication and integrity checking.

ESP Authentication Algorithms

The authentication algorithms available for ESP authentication are the same as for AH. See “AH Authentication Algorithms” for more information.

ESP Encryption Algorithms

To configure ESP, you must choose one of the following three encryption algorithms or the ESP-NULL algorithm:

- Data Encryption Standard in Cipher Block Chaining Mode (DES-CBC)
- Commercial Data Masking Facility (CDMF)
- Triple DES (3DES)

Note: The ESP encryption algorithms, except for ESP-NULL, are subject to U.S. export laws. If your 2212 does not allow you to configure some or all of

these algorithms, sale of those algorithms may be prohibited in your country. Check with your IBM representative for more information.

The NULL encryption algorithm, ESP-NULL, does not encrypt the plain text data and is available in all countries. It provides a way for ESP to provide authentication and integrity only - not encryption. When ESP-NULL is configured, one of the ESP authentication algorithms ***must*** be configured.

Tunnel Policy

A secure tunnel is configured with a tunnel policy that consists of one of these selections: AH, ESP, AH-ESP, or ESP-AH.

When both AH and ESP are configured, the following relationships apply:

- The policy AH-ESP means that for outbound packets, encryption is configured to run before authentication. In this case, inbound packets are checked by AH authentication first. Only the packets that are passed by AH authentication are forwarded to ESP for decryption.
- The policy ESP-AH means that for outbound packets, authentication is configured to run before encryption. In this case, inbound packets are decrypted by ESP first. Only the packets that are successfully decrypted are forwarded to AH authentication.

Security Associations

Security associations (SAs) are one-way security connections that can use either AH or ESP to protect connection traffic. Two security associations or an SA bundle is configured for each secure tunnel—one outbound and one inbound. Each security association is identified by its own security parameters index (SPI), which is an arbitrary 32-bit value.

Transport Mode and Tunnel Mode

Transport mode or tunnel mode determines the way in which IPsec handles the IP packets. The default is tunnel mode, which is required if the router is acting as a security gateway. Transport mode is allowed only when the router is acting as a host.

Modes Using AH

In transport mode, the AH is inserted after the IP header and before the header of an upper-layer protocol, such as TCP or UDP. In this mode, AH authenticates the upper-layer protocol header and the contents of the IP packet, except for the mutable fields in the IP header (such as time-to-live [TTL], checksum, fragment flag, fragment offset, and type of service [TOS]).

In tunnel mode, the AH is placed in front of the IP packet and a new IP header is created and placed in front of the AH. The IP header of the packet being tunnelled (called the inner IP header) carries the ultimate source and destination addresses of the packet. The new IP header (called the outer IP header) can contain the addresses of security gateways, which are the tunnel endpoints. The AH protects the entire new packet, both the new IP header and the IP packet being tunnelled, except for the mutable fields in the new IP header.

Modes Using ESP

In transport mode using ESP, the payload data contains upper-layer protocol data, such as TCP or UDP data. The upper-layer protocol data is encrypted. If authentication is used, the ESP header, the upper-layer protocol data, and the ESP trailer are authenticated.

In tunnel mode, the payload data contains the entire IP packet and a new IP header is created and placed in front of the ESP. The IP header of the packet being tunnelled (called the inner IP header) carries the ultimate source and destination addresses of the packet while the new IP header (called the outer IP header) contains the addresses of security gateways. The ESP encrypts the tunnelled IP packet. If ESP authentication is used, the ESP header, the tunnelled IP packet, and the ESP trailer are authenticated.

Configuring the Algorithms

Depending upon the tunnel policy, algorithms are configured as shown in Table 32.

Table 32. Algorithms Configured with Various Tunnel Policies

Tunnel Policy	Algorithms
AH, AH-ESP, or ESP-AH	• Local AH Authentication Algorithm—Required • Remote AH Authentication Algorithm—Optional
ESP, AH-ESP, or ESP-AH	• Local Encryption Algorithm—Required • Remote Encryption Algorithm—Optional • Local ESP Authentication Algorithm—Optional • Remote ESP Authentication Algorithm—Optional **Note:** If your software load does not include encryption, you will not see encryption-related parameters.

Local algorithms are applied to outbound packets and remote algorithms to inbound packets. The values for the remote algorithms are optional because each remote algorithm will take the value of the corresponding local algorithm as the default. The local ESP authentication algorithm is optional because authentication as part of ESP is an optional function.

The local algorithms configured by the sender for a particular secure tunnel must match the remote algorithms configured by the receiver at the far end of the secure tunnel. For example, if the sender tunnel policy is AH and the AH local authentication algorithm is HMAC-MD5, the receiver must have AH configured as one of its tunnel policies and the receiver's AH remote authentication algorithm must be HMAC-MD5.

Configuring Keys

For each algorithm configured, a key must be configured as well. Each key must match the key for the same algorithm in the host at the far end of the tunnel. For example, if the local encryption key for outbound packets is 0098B1C588A109D5, the remote encryption key for inbound packets in the host at the far end of the secure tunnel must also be configured as the same number. See the descriptions of the keys in the **add tunnel** command in "Chapter 16. Configuring and Monitoring IP Security" on page 185 for more information.

Tunnel-in-Tunnel

For added security in some situations, you may need to have a traffic stream of packets sent over two IPsec tunnels. Tunnel-in-tunnel is a feature that allows a packet to be encapsulated twice and sequentially transmitted through two tunnels. A packet filter access control rule identifies a packet for encapsulation for one IPsec tunnel. Before the packet is sent, a second access control rule causes the packet to be submitted to a second IPsec tunnel for a second encapsulation.

The two IPsec tunnels originate in the same router, but the remote end of each of the two tunnels is a different machine. The remote end of the second IPsec tunnel must be a secure gateway router; the remote end of the first tunnel can be either a secure gateway or a host. Because the first and second IPsec tunnels have different destinations, they must each have different remote IP addresses. The two IPsec tunnels used for tunnel-in-tunnel must be configured in tunnel mode. Extra padding is not allowed on the second IPsec tunnel.

After it has been encapsulated twice, the packet is sent over the second IPsec tunnel. At the end of the second tunnel, the second encapsulation is removed and the packet is forwarded to the first IPsec tunnel based on the header created by the first tunnel encapsulation. At the end of this tunnel, the first encapsulation is removed and the packet is forwarded to its final destination.

Path MTU Discovery

For both IPv4 and in IPv6, IPSec supports Path MTU (PMTU) Discovery when the 2212 is acting as a security gateway. Support of PMTU Discovery is a concern only when the secure tunnel is in tunnel mode and the packet cannot be fragmented. A packet cannot be fragmented in IPv4 if the Don't Fragment (DF) bit is set. Packets cannot be fragmented in IPv6 by intermediate routers. In these cases, if the packet will not fit on a link in the path from one end of the secure tunnel to the other, a "packet too big" ICMP error message will be generated and sent back to the originator of the packet.

Because the router is acting as a security gateway, this error packet will be returned to the originating router rather than to the true originator of the packet. The receiving router must appropriately pass the reported MTU back to the true originator. The originator can then reduce the size of the packets sent so that they will reach the final destination. Support for PMTU Discovery is discussed in the draft-ietf-ipsec-arch-sec-05 - Security Architecture for the Internet Protocol.

In IPv4, there are three options for setting the DF bit in the outer header of the packet to be tunnelled:

1. Copy from the inner header
2. Always set
3. Always clear

These choices are presented when configuring a secure tunnel in tunnel mode, for example, using the **add tunnel** command in Talk 6. The DF bit is handled according to the option selected except in the special case that occurs when the following conditions are met:

- The tunnel MTU is equal to the minimum MTU.
- The incoming packet length is less than or equal to the minimum MTU.
- The encapsulated packet would be greater than the minimum MTU.

In this case, for IPv4, the DF bit is not set, regardless of the configuration, and the secured packet will be allowed to be fragmented as necessary on the path to the remote tunnel endpoint. For IPv6, the packet will be fragmented as it leaves the security gateway to fit on the path MTU for the tunnel. This special action is necessary because the incoming packet is already less than or equal to the minimum MTU, so the originating host will not decrease the size any further. If fragmentation was not allowed, this packet would never reach its final destination

Because the path MTU can change due to changes in the network topology or configuration, the path MTU value must be periodically aged out and reset to the maximum. This aging timer defaults to 10 minutes and can be configured using the **set path** command in Talk 6. Setting the aging parameter to 0 disables PMTU aging.

Example 1: Configuring IPsec Tunnels in a Network

The network shown in Figure 16 provides an example of an IPsec tunnel that connects a router with IPsec to a router with both IPsec and Network Address Translation (NAT).

In this network, an IPsec tunnel with the IPsec tunnel ID 1 has been configured

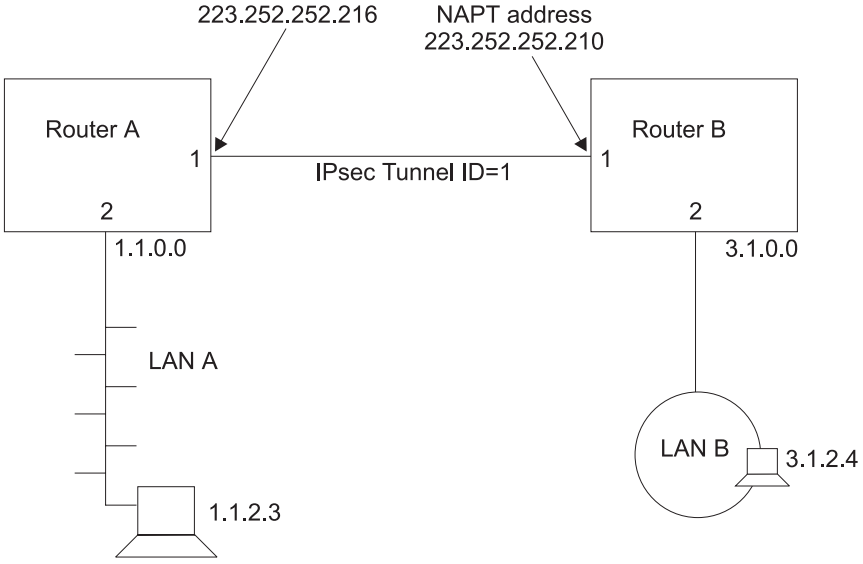


Figure 16. Network with IPsec and NAT

from IP address 223.252.252.216 in Router A to IP address 223.252.252.210 in Router B. Router A is configured for IPsec. Router B is configured for both IPsec and NAT. The following sections describe the process of configuring this network.

Note: If you do not plan to use NAT in your network, you will be more interested in Router A than Router B. However, reading over the description of configuring Router B can help you better understand the relationships between the parameters at each end of the IPsec tunnel.

Configuring Router A (IPsec Only)

First, follow these steps to configure Router A.

- Enable IPsec on the router using the **enable ipsec** command.

- Create the IPsec tunnel.
- Create one outbound and one inbound packet filter on the router interface that is the endpoint of the IPsec tunnel.
- Create access control rules for the packet filters.
- Reset IPsec.
- Reset IP.

Creating the IPsec Tunnel for Router A: The following example shows how to configure the IPsec tunnel 1 for Router A.

```
Config> feature ipsec
IP Security feature user configuration
IPsec config> add tunnel
IPsec Tunnel ID (1 - 65535) [1]
Tunnel Name (optional)? tunnelone
Tunnel Lifetime, in minutes (0-525600)[46080]?
Tunnel Encapsulation Mode (TUNN or TRANS) [TUNN]?
Tunnel Policy (AH, ESP, AH-ESP, ESP-AH) [AH-ESP]? AH
Local IP Address [1.1.1.1]? 223.252.252.216
Local Authentication SPI (256-65535)[256]?
Local Authentication Algorithm (HMAC-MD5, HMAC-SHA)[HMAC-MD5]?
Local Authentication Key (32 characters) in Hex (0-9,a-f,A-F):
Enter Local Authentication Key again (32 characters) in Hex (0-9,a-f,A-F):
Remote IP Address [0.0.0.0]? 223.252.252.210
Remote Authentication SPI (1-65535) [256]?
Remote Authentication Algorithm (HMAC-MD5, HMAC-SHA)[HMAC-MD5]?
Remote Authentication Key (32 characters) in Hex (0-9,a-f,A-F):
Enter Remote Authentication Key again (32 characters) in Hex (0-9,a-f,A-F):
Enable replay prevention? [No]:
Copy, set, or clear DF bit in outer header (COPY,SET,CLEAR) [COPY]?
Do you wish to enable this tunnel? [Yes]:
Ipsec config>
```

As you can see from this example, you are prompted for the parameters that you need to provide. The configuration of an ESP, AH-ESP, or ESP-AH secure tunnel calls for similar parameters.

Note: The values of the keys are not displayed when they are entered. Therefore, they are not visible in this example. If the keys for HMAC-MD5 authentication were visible, you would see 32 hex characters. For example, a key could have a value such as X'1234567890ABCDEF1234567890ABCDEF'.

Configuring Packet Filters for Router A: After you have created the IPsec tunnel for Router A, you must set up two IP packet filters: one outbound packet filter and one inbound packet filter. The creation of the packet filter *out-router-A* is shown in the following example. Refer to the IP access control sections in the IP chapters in *Protocol Configuration and Monitoring Reference, Vol. 1* for more information about configuring IP packet filters and access control rules.

```
*talk 6
Config> Protocol IP
Internet protocol user configuration
IP Config> set access-control on
IP Config> add packet-filter
Packet-filter name [ ]? out-router-A
Filter incoming or outgoing traffic? [IN]? OUT
Which interface is this filter for [0]? 1
IP Config>update packet-filter
Packet-filter name [ ]? out-router-A
Packet-filter 'out-router-A' Config>
```

In the same way, create an inbound packet filter for Router A on interface 1 in Router A called *in-router-A*. The packet filters are created on interface 1 because that is the endpoint of IPsec tunnel 1.

Configuring Packet Filter Access Control Rules for Router A: The next step is to configure the packet filter access control rules. You should create two access control rules on the outbound packet filter *out-router-A* and two access control rules on the inbound packet filter *in-router-A*.

Note: Each IPsec tunnel must have an inbound and an outbound packet filter configured and two access control rules configured for each packet filter.

The access control rules on the outbound packet filter perform these functions:

- One access control rule defines the range of the source and destination addresses of the packets to be passed into the IPsec tunnel.
- The other access control rule allows IPsec traffic to pass through the packet filter.

The access control rules on the inbound packet filter perform these functions:

- One access control rule allows inbound IPsec traffic to pass through the packet filter.
- The other access control rule is an IPsec redundant check that examines the source and destination addresses of the packets that have been processed by IPsec. This access control rule assures that these source and destination addresses match the source and destination addresses of the packets that were outbound from the far end of the IPsec tunnel.

The first access control rule for *in-router-A* passes traffic over the IPsec tunnel by identifying the two endpoints of the IPsec tunnel. The protocol range 50 - 51 identifies IPsec.

```
IP Config> update packet-filter
Packet-filter name [ ]? in-router-A
Packet-filter 'in-router-A' Config> add access
Enter type [E]? I
Internet source [0.0.0.0]? 223.252.252.210
Source mask [255.255.255.255]?
Internet destination [0.0.0.0]? 223.252.252.216
Destination mask [255.255.255.255]?
Enter starting protocol number ([0] for all protocols) [0]? 50
Enter ending protocol number [50]? 51
(Enable logging? (Yes or [No]):
Packet-filter 'in-router-A' Config>
```

The second access control rule for *in-router-A* checks the source and destination addresses of IPsec-processed packets on Router A to confirm that they are the same as the source and destination addresses of packets sent from Router B. This extra check on the security of the IPsec tunnel is redundant because the outbound packet filter on Router A should never pass packets with a source and destination address that does not match the source and destination address expected on the inbound packets at Router B. However, it is recommended in the IETF security architecture draft.

Note: Because Router B is using NAT, Router A does not have access to Router B's 3.1.0.0 addresses. For this reason, the second access control rule for *in-router-A* uses the address 223.252.252.210 rather than subnet 3.1.0.0 as the remote source address.

```
Packet-filter 'in-router-A' Config> add access
Enter type [E]? IS
Internet source [0.0.0.0]? 223.252.252.210
Source mask [255.255.255.255]?
Internet destination [0.0.0.0]? 1.1.0.0
Destination mask [255.255.255.255]? 255.255.0.0
Enter starting protocol number ([0] for all protocols) [0]?
Enter IPsec Tunnel ID [1]?
(Enable logging? (Yes or [No]):
Packet-filter 'in-router-A' Config> exit
```

If you want all packets that do not match any access control rule to be passed rather than dropped, you can configure an inclusive wildcard access control rule to pass these packets. However, this access control rule invalidates the second inbound access control rule on the inbound packet filter because it passes the packets that the access control rule is designed to drop. The following example shows such an access control rule:

```
Packet-filter 'in-router-A' Config> add access
Enter type [E]? I
Internet source [0.0.0.0]?
Source mask [255.255.255.255]? 0.0.0.0
Internet destination [0.0.0.0]?
Destination mask [255.255.255.255]? 0.0.0.0
Enter starting protocol number ([0] for all protocols) [0]?
Enable Logging (Yes or [No]):
Packet-filter 'in-router-A' Config> exit
```

Next, configure the first access control rule for packet filter *out-router-A*. This access control rule passes packets from subnet 1.1.0.0 to the destination address 223.252.252.210 in Router B.

```
IP Config> update packet-filter
Packet-filter name [ ]? out-router-A
Packet-filter 'out-router-A' Config> add access
Enter type [E]? IS
Internet source [0.0.0.0]? 1.1.0.0
Source mask [255.255.255.255]? 255.255.0.0
Internet destination [0.0.0.0]? 223.252.252.210
Destination mask [255.255.255.255]?
Enter starting protocol number ([0] for all protocols) [0]?
Enter IPsec Tunnel ID [1]?
(Enable logging? (Yes or [No]):
Packet-filter 'out-router-A' Config>
```

The second access control rule for *out-router-A* allows packets to pass between the two ends of the IPsec tunnel.

```
Packet-filter 'out-router-A' Config> add access
Enter type [E]? I
Internet source [0.0.0.0]? 223.252.252.216
Source mask [255.255.255.255]?
Internet destination [0.0.0.0]? 223.252.252.210
Destination mask [255.255.255.255]?
Enter starting protocol number ([0] for all protocols) [0]? 50
Enter ending protocol number [50]? 51
(Enable logging? (Yes or [No]):
Packet-filter 'out-router-A' Config>
```

As with the other packet filters, you may want to configure a wildcard access control rule for *out-router-A* to pass traffic that does not match any access control rules.

Resetting IPsec and IP on Router A: After you complete your IPsec configuration, use the **reset ipsec** command in Talk 5 to reload SRAM with the new IPsec configuration that you created in Talk 6. The **reset ipsec** command does not affect any IP configuration. Then, use the **reset ip** command in Talk 5 to dynamically reset IP within the router. Alternatively, to reset each component, you can restart the router. It is necessary to reset IPsec and IP or to restart the router to assure that the packet filters and access rules are reloaded. Otherwise, your configuration may not be correctly supported on the interface. See “Chapter 16. Configuring and Monitoring IP Security” on page 185 and the **reset ip** command in the *Protocol Configuration and Monitoring Reference, Vol. 1* for more information.

Configuring Router B (IPsec and NAT)

IPsec tunnel 1 has an endpoint on interface 1 in Router B. Router B will be configured for both IPsec and for NAT. When NAT is configured, you use the outbound packet filter on the router to pass outbound packets through NAT

translation and IPsec encapsulation. The inbound packets pass IPsec for decryption first and then are passed to NAT for translation.

Follow these steps to configure Router B.

- Configure NAT.
- Create the IPsec tunnel.
- Create one outbound and one inbound packet filter on the router interface that is the endpoint of the IPsec tunnel.
- Create access control rules for the packet filters.
- Reset IPsec.
- Reset NAT.
- Reset IP.

The configuration of NAT in Router B is not discussed here. See “Chapter 19. Using Network Address Translation” on page 221 and “Chapter 20. Configuring and Monitoring Network Address Translation” on page 227 for information about configuring NAT. This example assumes that NAT has been configured and that the NAPT address 223.252.252.210 is also the endpoint of the IPsec tunnel. The NAT private address pool in this example is 3.1.0.0 with the subnet 255.255.0.0. Inbound traffic arriving from IPsec tunnel 1 will be processed by IPsec, then passed to NAT for translation to one of these addresses.

Notes:

1. In this example, the IPsec tunnel endpoint address and the NAPT address are the same. However, in cases like this, when IPsec and NAT are used together, the address of the IPsec tunnel endpoint can be any valid IP address, not necessarily the NAPT address or one of the NAT public addresses.
2. If you are not concerned with NAT, you can regard the address 223.252.252.210 as the endpoint of IPsec tunnel 1 and the address range 3.1.0.0 simply as the address range of packets to be passed to IPsec.

Creating the IPsec Tunnel for Router B: Within Router B, the same IPsec tunnel that was configured for Router A, IPsec tunnel 1, must be configured. The local IP address of this tunnel in Router B is 223.252.252.210 and the remote IP address is 223.252.252.216. All other IPsec tunnel parameters must match the parameters that were configured for Router A.

Configuring Packet Filters for Router B: As you did for Router A, configure an inbound packet filter (*in-router-B*) and an outbound packet filter (*out-router-B*) on interface 1, which is the interface in Router B that is the endpoint of the IPsec tunnel 1.

Configuring Packet-Filter Access Control Rules for Router B: First, configure the first inbound access control rule for the inbound packet filter *in-router-B* on Router B. This access control rule identifies the two endpoints of the IPsec tunnel and allows Router B to receive packets from the tunnel. This packet filter *in-router-B* is type inclusive (I).

```
IP Config> update packet-filter
Packet-filter name [ ] in-router-B
Packet-filter 'in-router-B' Config> add access
Enter type [E]? I
Internet source [0.0.0.0]? 223.252.252.216
Source mask [255.255.255.255]?
Internet destination [0.0.0.0]? 223.252.252.210
Destination mask [255.255.255.255]?
Enter starting protocol number ([0] for all protocols) [0]? 50
```

```
Enter ending protocol number [50]? 51
Enable logging? (Yes or [No]):
Packet-filter 'in-router-B' Config>
```

Next, you can add the second access control rule to *in-router-B*.

This extra check on the security of the IPsec tunnel is redundant in IPsec However, this additional access control rule is required by NAT. Note that the access control rule is type I, N, and S.

```
Packet-filter 'in-router-B' Config> add access
Enter type [E]? INS
Internet source [0.0.0.0]? 1.1.0.0
Source mask [255.255.255.255]? 255.255.0.0
Internet destination [0.0.0.0]? 223.252.252.210
Destination mask [255.255.255.255]?
Enter starting protocol number ([0] for all protocols) [0]?
Enter IPsec Tunnel ID [1]?
Enable logging? (Yes or [No]):
Packet-filter 'in-router-B' Config>
```

If you want all packets that do not match any access control rule to be passed rather than dropped, you can configure an inclusive wildcard access control rule for *in-router-B* to pass these packets. However, this access control rule invalidates the second inbound access control rule on the inbound packet filter because this access control rule passes the packets that the second access control rule is designed to drop.

Next, configure an access control rule on *out-router-B* to pass outbound packets from subnet 3.1.0.0 to NAT for translation and then to IPsec for processing and transmission through IPsec tunnel 1. This access control rule is type I, N, and S.

```
Packet-filter name [ ]? out-router-B
Packet-filter 'out-router-B' Config> add access
Enter type [E]? INS
Internet source [0.0.0.0]? 3.1.0.0
Source mask [255.255.255.255]? 255.255.0.0
Internet destination [0.0.0.0]? 1.1.0.0
Destination mask [255.255.255.255]? 255.255.0.0
Enter starting protocol number ([0] for all protocols) [0]?
Enter IPsec Tunnel ID [1]?
Enable logging? (Yes or [No]):
Packet-filter 'out-router-B' Config>
```

Now, for *out-router-B*, create an inclusive access control rule to let packets that have been processed by IPsec pass through IPsec tunnel 1.

```
Packet-filter 'out-router-B' Config> add access
Enter type [E]? I
Internet source [0.0.0.0]? 223.252.252.210
Source mask [255.255.255.255]?
Internet destination [0.0.0.0]? 223.252.252.216
Destination mask [255.255.255.255]?
Enter starting protocol number ([0] for all protocols) [0]? 50
Enter ending protocol number [50]? 51
(Enable logging? (Yes or [No]):
Packet-filter 'out-router-B' Config>
```

For *out-router-B*, create an inclusive wildcard access control rule if you wish to pass rather than drop packets that do not match either of the two access control rules, for example, traffic not destined for IPsec tunnel 1.

Resetting NAT, IPsec, and IP on Router B: Before the NAT and IPsec functions will work and the IP access control rules are activated, NAT, IPsec, and IP have to be reset. Use the talk 5 **reset NAT** and **reset IPsec** commands to reset NAT and IPsec. See “Chapter 20. Configuring and Monitoring Network Address Translation”

on page 227 for more information about resetting NAT and “Resetting IPsec and IP on Router A” on page 179 for information about resetting IPsec. After NAT and IPsec are reset, use the talk 5 **reset IP** command to reset IP. Alternatively, to reset each component, you can restart the router.

Example 2: Configuring an IPsec Tunnel with ESP

Note that you are prompted to set the DF bit when the tunnel is in tunnel mode and the tunnel policy is ESP. This example shows only the configuration of the IPsec tunnel, not of the packet filters.

```
IPsec config>add tun
Tunnel ID or Tunnel Name [ ]? 3
Tunnel Lifetime, in minutes (0-525600) [46080]?
Tunnel Encapsulation Mode (TUNN or TRANS) [TUNN]?
Tunnel Policy (AH,ESP,AH-ESP,ESP-AH) [ESP]?
IP version (4 or 6) [4]?
Local IP Address [1.1.1.1]?
Local Encryption SPI (256-65535) [256]?
Local Encryption Algorithm (DES-CBC,CDMF,3DES, NULL) [DES-CBC]?
Do you wish to change the Local Encryption Key? (Yes or [No]):
Additional Padding for Local Encryption (0-120) [0]?
Do you wish to use local ESP authentication? [Yes]:
Remote IP Address [0.0.0.0]?
Remote Encryption SPI (1-65535) [256]?
Remote Encryption Algorithm (DES-CBC,CDMF) [DES-CBC]?
Do you wish to change the Remote Encryption Key? (Yes or [No]):
Do you wish to perform verification of remote encryption padding? [No]:
Do you wish to use remote ESP authentication? [No][No]:
Copy, set or clear DF bit in outer header (COPY,SET,CLEAR) [COPY]?
Do you wish to enable this tunnel? [Yes]:
IPsec config>
```

Example 3: Configuring an IPsec Tunnel with ESP Using the ESP-NULL Algorithm

Note that authentication is required.

```
IPsec config>add tun
Tunnel ID or Tunnel Name [ ]? 3
Tunnel Lifetime, in minutes (0-525600) [46080]?
Tunnel Encapsulation Mode (TUNN or TRANS) [TUNN]?
Tunnel Policy (AH,ESP,AH-ESP,ESP-AH) [ESP]?
IP version (4 or 6) [4]?
Local IP Address [1.1.1.1]?
Local Encryption SPI (256-65535) [256]?
Local Encryption Algorithm (DES-CBC,CDMF,3DES,NULL) [DES-CBC]? null
Additional Padding for Local Encryption (0-120) [0]?
Local ESP Authentication Algorithm (HMAC-MD5,HMAC-SHA) [HMAC-MD5]?
Local ESP Authentication Key (32 characters) in Hex (0-9,a-f,A-F):
Enter Local ESP Authentication Key again (32 characters) in Hex (0-9,a-f,A-F):
Remote IP Address [0.0.0.0]? 10.11.12.11
Remote Encryption SPI (1-65535) [1234]?
Remote Encryption Algorithm (DES-CBC,CDMF,3DES,NULL) [NULL]?
Do you wish to perform verification of remote encryption padding? [No]:
Remote ESP Authentication Algorithm (HMAC-MD5,HMAC-SHA) [HMAC-MD5]?
Remote ESP Authentication Key (32 characters) in Hex (0-9,a-f,A-F):
Enter Remote ESP Authentication Key again (32 characters) in Hex (0-9,a-f,A-F):
Enable replay prevention? [No]:
Copy, set or clear DF bit in outer header (COPY,SET,CLEAR) [COPY]?
Do you wish to enable this tunnel? [Yes]:
IPsec config>
```

Using IP Security with IPv6 Tunnels

All IPsec functions apply to IPv6. Observe the following changes to the IPsec configuration questions when you are configuring IPsec for IPv6:

- When you are configuring IPsec for IPv6, you will enter addresses in IPv6 address format (for example, 8:0:9:8::1).
- You will not be queried for the DF bit setting.
- Before local and remote information is requested, you will be asked an additional question requesting that you specify IPv4 or IPv6.

Chapter 16. Configuring and Monitoring IP Security

This chapter describes how to configure and monitor IP security and how to use the IP security monitoring commands. It includes the following sections:

- "Accessing the IP Security Configuration Environment"
- "IP Security Configuration Commands"
- "Accessing the IP Security Monitoring Environment" on page 193
- "IP Security Monitoring Commands" on page 193

Note: If you create an IPsec tunnel to transport TN3270, APPN-ISR, or APPN-HPR traffic and you plan to prioritize that traffic using BRS, you need to use the IPv4 precedence bit setting feature of BRS. See "Using IP Version 4 Precedence Bit Processing for SNA Traffic in IP Secure Tunnels and Secondary Fragments" on page 8 for more information.

Accessing the IP Security Configuration Environment

To access the IP Security configuration environment, enter the following command at the `Config>` prompt:

```
Config> feature ipsec
IP Security feature user configuration
IPsec config>
```

IP Security Configuration Commands

This section describes the IP security configuration commands. Enter these commands at the `IPsec config>` prompt.

Table 33. IP Security 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 xxvi.
Add tunnel	Adds a secure tunnel.
Change tunnel	Changes a secure tunnel configuration parameter values.
Delete tunnel	Deletes a secure tunnel.
Disable	Disables all IP Security processing in a secure manner (packets that match the packet filters are dropped), disables all IP Security processing in a nonsecure manner (packets that match the packet filters are passed), or disables a secure tunnel.
Enable	Enables all IP Security processing, or enables a secure tunnel.
List	Lists information about global IP Security information, or information about defined tunnels.
Set	Sets the Path MTU (PMTU) aging timer.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Add Tunnel

Use the **add tunnel** command to add the parameters to define an IPsec tunnel.

Syntax:

add tunnel...

tunnel-id

Required number that specifies the identifier of the secure tunnel to be added. Each tunnel id must be unique within the 2212.

Valid values: 1 - 65535

Default value: none

tunnel-name

Optional parameter to label the tunnel. It must be unique within the 2212.

Valid values: up to 15 characters; first character must be a letter; no blanks can be used.

Default value: none

lifetime

Time in minutes that the tunnel can be active. The value 0 indicates that the tunnel lifetime never expires.

Valid Values: 0 - 525600 (0 = no expiration; 525600 = 365 days)

Default Value: 46080 (32 days)

encapsulation-mode

The manner in which the IP packet is encapsulated. In tunnel mode, the entire IP packet is encapsulated and a new IP header is created; in transport mode, the IP header is not encapsulated. If one end of the secure tunnel is a router, then tunnel mode ***must*** be used, according to the Internet Engineering Task Force (IETF) security architecture draft.

Valid Values: tunnel (*TUNN*) or translate (*TRANS*)

Default Value: tunnel (*TUNN*)

tunnel-policy

One of the four choices that define the tunnel policy: IP Authentication Header (AH), IP Encapsulating Security Payload (ESP), or combinations of these protocols (AH-ESP and ESP-AH). In AH-ESP, ESP encryption is run first on the outbound packets; in ESP-AH, AH authentication is run first on the outbound packets. Some parameters are unique either to ESP or AH. The encryption parameters are configured only if ESP, AH-ESP, or ESP-AH is selected; the authentication parameters are configured only if AH, AH-ESP, or ESP with authentication is selected.

Valid Values: AH, ESP, AH-ESP, ESP-AH

Default Value: AH-ESP

IP-version

The version of IP to be used for the tunnel.

Valid Values: IPv4 or IPv6

Default Value: IPv4

local-IP-address

IP address for this end of the tunnel.This address is either IPv4 or IPv6 depending upon the IP version that has been configured.

Valid Values: a valid IP address that has been configured either for an interface or as the internal address of the 2212.

Default Value:one of the IP addresses configured for the router

local-spi

A security association is a one-way security connection that uses AH or ESP to protect connection traffic. The security parameters index (SPI) is an arbitrary 32-bit value that uniquely identifies one of the two security associations (inbound or outbound) associated with this secure tunnel. This parameter, which is required, identifies the SPI expected in this tunnel for inbound packets received at the local end of the tunnel. This value cannot match the local SPI of another tunnel with the same local IP address. Regardless of the tunnel policy (ESP, AH, AH-ESP, or ESP-AH), only one local SPI is configured for inbound traffic for one IP secure tunnel.

Valid Values: 256 - 65535

Default Value: 256

local-encryption-algorithm

The encryption algorithm used for ESP on outbound packets sent from the local router, which is required when configuring ESP. In some countries, some or all of these algorithms may be unavailable because of U.S. export rules. This encryption algorithm must match the remote encryption algorithm.

The ESP-NULL algorithm prevents ESP from performing encryption. This algorithm is available in all countries. If ESP-NULL is selected, ESP must be activated for authentication by selecting one of the authentication algorithms HMAC-MD5 or HMAC-SHA-1.

Valid Values: DES-CBC, CDMF, 3DES, or ESP-NULL

Default Value: DES-CBC

local-encryption-key

The key or keys used with the local ESP encryption algorithm. They must match the equivalent keys that are configured in the opposite end of the secure tunnel. This key is not configured when the ESP-NULL encryption algorithm is selected.

Valid Values:

- For DES-CBC: 16 hex characters (0 - 9, a - f, A - F)
- For CDMF: 16 hex characters (0 - 9, a - f, A - F)
- For 3DES: three separate keys, none of which is the same, each one 16 hex characters (0 - 9, a - f, A - F)

Default Value: none

padding-for-local-encryption

Size in bytes of additional padding that is added to outbound ESP packets. Additional padding may be used to disguise the size of the IP packets being encrypted when the encryption algorithm results in an encrypted packet that is the same size as the original packet. ESP padding values must be a multiple of 8. If a value that is not divisible by 8 is configured, that value is rounded up to the next value that is divisible by 8.

When the encryption algorithm is ESP-NULL, padding is not necessary because the ESP-NULL algorithm adds one byte to the original packet size. If padding for local encryption is configured, the value is ignored.

Valid Values: 0 - 120

Default Value: 0

local-ESP-authentication

Selects local ESP authentication, if desired. Authentication is required if the encryption algorithm is ESP-NULL.

Valid Values: Yes or No

Default Value: Yes

local-authentication-algorithm

The authentication algorithm used on outbound packets. This is an optional parameter for ESP and will not be required unless you select ESP authentication. For AH , AH-ESP, or ESP-AH, this parameter is required. The authentication algorithm used must match the remote authentication algorithm used at the far end of the IPsec tunnel.

Valid Values: HMAC-MD5 or HMAC-SHA

Default Value: HMAC-MD5

local-authentication-key

The key used with the local authentication algorithm. It must match the equivalent key that is configured in the opposite end of the IPsec tunnel. It is required if the policy is AH, AH-ESP, or ESP-AH, or if the policy is ESP and the local ESP authentication algorithm has been configured.

Valid Values:

- for HMAC-MD5: 32 hex characters (0 - 9, a - f, A - F)
- for HMAC-SHA: 40 hex characters (0 - 9, a -f, A - F)

Default Value: none

remote-IP-address

IP address for the remote end of the tunnel. This is a required parameter. This address is either IPv4 or IPv6 depending upon the IP version that has been configured.

Valid Values: a valid IP address

Default Value: none

remote-spi

A security association is a one-way security connection that uses AH or ESP to protect connection traffic. The security parameters index (SPI) is an arbitrary 32-bit value that uniquely identifies one of the two security associations (inbound or outbound) associated with this secure tunnel. This parameter, which is required, identifies the SPI expected in ESP or AH for outbound packets destined for the remote host. This value cannot match the remote SPI of another tunnel with the same remote IP address. Regardless of the tunnel policy (ESP, AH, AH-ESP, or ESP-AH), only one local SPI is configured for outbound traffic for one IPsec tunnel.

Valid Values: 1 - 65535

Default Value: 256

remote-encryption-algorithm

The decryption algorithm used on inbound packets received from the remote host. It must match the local encryption algorithm.

The ESP-NULL algorithm prevents ESP from performing encryption. If ESP-NULL is selected, ESP must be activated for authentication by selecting one of the authentication algorithms HMAC-MD5 or HMAC-SHA-1.

Valid Values: DES-CBC, CDMF, 3DES, or ESP-NULL

Default Value: value of the local encryption algorithm

remote-encryption-key
The key or keys used with the remote ESP encryption algorithm. They must match the equivalent keys that are configured in the opposite end of the secure tunnel. This key is not configured when the ESP-NULL encryption algorithm is selected.

Valid Values:

- For DES-CBC: 16 hex characters (0 - 9, a - f, A - F)
- For CDMF: 16 hex characters (0 - 9, a - f, A - F)
- For 3DES: three separate keys, none of which matches, each 16 characters in hex (0 - 9, a - f, A - F)

Default Value: none

verification-of-remote-encryption-padding
Determines whether the size of the encryption padding on received packets should be verified.

Valid Values: Yes or No

Default Value: No

padding-for-remote-encryption
Size in bytes of additional padding that is expected in received ESP packets. This parameter is required and valid only if the value of *verification-of-remote-encryption-padding* is Yes. ESP padding values must be a multiple of 8. If a value that is not divisible by 8 is configured, that value will be rounded up to the next value that is divisible by 8.

Valid Values: 0 - 120

Default Value: 0

remote-ESP-authentication
Selects remote ESP authentication for inbound packets, if desired.

Valid Values: Yes or No

Default Value: Yes

remote-authentication-algorithm
The authentication algorithm used for inbound packets. This is an optional parameter for ESP and will not be required unless you select ESP authentication. For AH or combinations of AH and ESP (AH-ESP or ESP-AH), this parameter is required. The authentication algorithm used must match the local authentication algorithm used at the far end of the IPsec tunnel.

Valid Values: HMAC-MD5 or HMAC-SHA

Default Value: HMAC-MD5

remote-authentication-key
The key used with the remote authentication algorithm. It must match the equivalent key that is configured in the opposite end of the secure tunnel. It is required in AH, AH-ESP and ESP-AH and in ESP if the remote ESP authentication algorithm has been configured.

Valid Values:

- for HMAC-MD5: 32 hex characters (0 - 9, a - f, A - F)
- for HMAC-SHA: 40 hex characters (0 - 9, a -f, A - F)

Default Value: none

enable-replay-prevention
Specifies whether replay prevention is enabled. If replay prevention is enabled, the sequence numbers in the IP security headers are monitored to prevent duplicate packets from being processed by the tunnel receiver. The use of replay prevention is not recommended because the tunnel security association must be deactivated when a sender's sequence number counter reaches its limit. When this happens, manual intervention is required to restart the existing security association or create a new one.

In addition, if replay prevention is enabled and you reset IPsec using the **reset ipsec** command, you must make sure that IPsec is also reset on the router at the other end of the IPsec tunnel. This is necessary to re-initialize the sequence number at both ends of the tunnel. If IPsec is reset on one end of the tunnel and not on the other, it is possible that routers at each end of the tunnel will drop packets due to sequence number mismatch.

Valid Values: Yes or No

Default Value: No

DF-bit Specifies the handling of the Don't Fragment (DF) bit in the outer header for tunnel mode secure tunnels. This bit can be set in IPv4 headings to specify that the packet cannot be fragmented. The DF-bit parameter tells the 2212 how it should handle the DF bit on incoming packets - whether to copy the value of the DF-bit found in the inner header to the outer header, or whether to set or clear the bit in the outer header.

If the DF bit is set and the packet cannot be fragmented, IPsec uses the Path MTU (PMTU) Discovery function. See "Path MTU Discovery" on page 175 for more information.

Valid Values: Copy, Set, Clear

Default Value: Copy

enable-tunnel
Specifies whether this tunnel is enabled. The enabled tunnel will not filter packets until a packet filter has been configured to define the interface over which this IPsec tunnel will operate and IP has been reset or restarted on the 2212. You can use the **reset ip** command to reset IP.

Valid Values: Yes or No

Default Value: Yes

Change Tunnel

Use the **change tunnel** command to change an IPsec tunnel parameter previously configured by the **add tunnel** command.

Syntax:

change tunnel...	See the **add tunnel** command for a list of the parameters that can be changed.

Delete Tunnel

Use the **delete tunnel** command to delete an IPsec tunnel.

Syntax:

delete tunnel *tunnel-id tunnel-name* **all**

tunnel-id
Specifies the identifier of the IPsec tunnel to be deleted.

Valid Values: 1 - 65535

Default Value: 1

tunnel-name
Specifies the name of the IPsec tunnel to be deleted.

Valid Values: any configured tunnel name

Default Value: none

all Specifies that all IPsec tunnels on this interface are to be deleted.

Disable

Use the **disable** command to disable the IPsec tunnel or to disable all IPsec tunnels either in a secure manner (packets that match the IPsec filters are dropped) or an insecure manner (packets that match the IPsec filters are passed).

Syntax:

disable ipsec drop
ipsec pass
tunnel ...

ipsec drop
Disables IP security on the router in a secure manner. All IPsec tunnels will be disabled, but the secure tunnel information in packet filter rules is used to identify packets that match IPsec tunnel packet filters. The matching packets are dropped.

ipsec pass
Disables IP security on the router in a non-secure manner. All IPsec tunnels will be disabled. Packets that match IPsec tunnel packet filters are forwarded as ordinary traffic.

tunnel *tunnel-id* **all**
Disables IP security on a specified tunnel or on all tunnels.

tunnel-id
Specifies the identifier of the secure tunnel to be disabled.

Valid Values: 1 - 65535

Default Value: 1

all All tunnels.

Enable

Use the **enable** command to enable the IP Security protocol on all interfaces or a single tunnel. You must enable ipsec globally on the router before the individually enabled IPsec tunnels become active.

Syntax:

enable ipsec
tunnel ...

ipsec Enables IP security throughout the router.

tunnel *tunnel-id* **all**
Enables IP security on a specified tunnel or on all tunnels.

tunnel-id
Specifies the identifier of the secure tunnel to be enabled.

Valid Values: 1 - 65535

Default Value: 1

all All tunnels.

List

Use the **list** command to display the current IP Security configuration. Global tunnels include all tunnels in the router, both active and defined. All tunnels include all tunnels configured on this interface, both active and defined. Active tunnels are those that are currently active; defined tunnels are defined but not active.

Syntax:

list ... all
global
tunnel
active *tunnel-id tunnel-name* all
defined *tunnel-id tunnel-name* all

Example 1: Listing all IPsec tunnels

```
IPsec config>list all

IPsec is ENABLED

IPsec Path MTU Aging Timer is 20 minutes

Defined Manual Tunnels:

   ID         Name         Local IP Addr   Remote IP Addr   Mode    State
 ------  ---------------  ---------------  ---------------  -----  --------
      1  test                      1.1.1.1          2.1.1.1  TUNN   Enabled
      2  test2                     1.1.1.1          1.1.1.3  TRANS  Enabled

Tunnel Cache:

 ID     Local IP Addr   Remote IP Addr   Mode   Policy  Tunnel Expiration
-----  ---------------  ---------------  -----  ------  ------------------
    2          1.1.1.1          1.1.1.3  TRANS  ESP     ******************
    1          1.1.1.1          2.1.1.1  TUNN   AH      ******************
```

Example 2: Listing an IPsec tunnel with the ESP policy and the ESP-NULL algorithm

```
IPsec config>li tun 1000

Tunnel  Name            Mode   Policy   Life   Replay  Rcv  IPsec  State
ID                                              Prev    Win  Vers
------  --------------  -----  ------  ------  ------  ---  -----  --------
1000    t1000           TUNN   ESP      46080    No    ---   V2    Enabled

Handling of DF bit in outer header:  COPY

Local Information:

      IP Address: 10.11.12.10
  Authentication:  SPI: -----    Algorithm: ----------
      Encryption:  SPI:  1234    Encryption Algorithm: NULL
                                 Extra Pad:   0
                                 ESP Authentication Algorithm: HMAC-MD5
Remote Information:

      IP Address: 10.11.12.11
  Authentication:  SPI: -----    Algorithm: ----------
      Encryption:  SPI:  1234    Encryption Algorithm: NULL
                                 Verify Pad?:  No
                                 ESP Authentication Algorithm: HMAC-MD5
```

Set

Sets the aging timer for the Path MTU (PMTU).

Syntax:

set ... path

path-MTU-aging-timer

This parameter defines the time in minutes that will elapse before the 2212 sets the tunnel MTU back to the maximum.

Valid Values: 10 - 60 minutes; 0 means disabled

Default Value: 10

Accessing the IP Security Monitoring Environment

To access the IP Security monitoring environment type **t 5** at the OPCON prompt (*):

```
* t 5
```

Then, enter the following command at the **+** prompt:

```
+ feature ipsec
IPsec>
```

IP Security Monitoring Commands

This section describes the IP Security monitoring commands. Enter these commands at the IPsec> prompt.

Table 34. IP Security 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 xxvi.
Add tunnel	Dynamically adds a secure tunnel.

Table 34. IP Security Monitoring Commands Summary (continued)

Command	Function
Change tunnel	Dynamically changes a secure tunnel configuration parameter values.
Delete tunnel	Dynamically deletes a secure tunnel.
Disable	Dynamically disables all IP Security processing in a secure manner (matching packets are dropped), disables all IP Security processing in a nonsecure manner (matching packets are forwarded), or disables a particular secure tunnel.
Enable	Dynamically enables all IP Security processing, or enables a secure tunnel.
List	Lists information about global IP Security information, or information about active and defined tunnels.
Reset	Resets IP Security or resets a secure tunnel. This command reloads the configuration that was created in Talk 6. Resetting will override the values of parameters configured using Talk 5 with those that were configured using Talk 6.
Restart	Restarts IP Security or restarts a secure tunnel. This command reloads the configuration information that has been dynamically configured using Talk 5 commands.
Set	Dynamically sets the Path MTU (PMTU) aging timer.
Stats	Displays statistics for all tunnels or for an active tunnel.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Add Tunnel

Dynamically adds a secure tunnel.

Syntax:

add tunnel ...

See the **add tunnel** command under “IP Security Configuration Commands” on page 185 for a description of the parameters.

Change Tunnel

Dynamically changes a secure tunnel.

Syntax:

change tunnel ...

See the description of the **add tunnel** command under “IP Security Configuration Commands” on page 185 for a description of the parameters.

Delete Tunnel

Use the **delete** command to dynamically delete a secure tunnel or all secure tunnels.

Syntax:

delete tunnel *tunnel-id tunnel-name* **all**

tunnel-id
Specifies the identifier of the IPsec tunnel to be deleted.

Valid Values: 1 - 65535

Default Value: 1

tunnel-name
Specifies the name of the IPsec tunnel to be deleted.

Valid Values: any configured tunnel name

Default Value: none

all Specifies that all IPsec tunnels on this interface are to be deleted.

Disable

Use the **disable** command to dynamically disable the IP Security protocol on all interfaces or a single tunnel.

Syntax:

disable ipsec drop
ipsec pass
tunnel ...

ipsec drop
Disables IP security on the router in a secure manner. All IPsec tunnels will be disabled, but the secure tunnel information in packet filter rules is used to identify packets that match IPsec tunnel packet filters. The matching packets are dropped.

ipsec pass
Disables IP security on the router in a non-secure manner. All IPsec tunnels will be disabled. Packets that match IPsec tunnel packet filters are forwarded as ordinary traffic.

tunnel *tunnel-id* **all**
Disables IP security on a specified tunnel or on all tunnels.

tunnel-id
Specifies the identifier of the secure tunnel to be disabled.

Valid Values: 1 - 65535

Default Value: 1

all All tunnels.

Enable

Use the **enable** command to dynamically enable the IP Security protocol on all interfaces or a single tunnel. You must enable ipsec globally on the router before the individually enabled IPsec tunnels become active.

Note: IPsec cannot be dynamically enabled if the router was restarted with IPsec disabled.

Syntax:

enable ipsec

tunnel ...

ipsec Enables IP security throughout the router.

tunnel *tunnel-id* **all**

tunnel-id
Specifies the identifier of the secure tunnel to be enabled.

Valid Values: 1 - 65535

Default Value: 1

all All tunnels.

List

Use the **list** command to display the current IP Security configuration. Global tunnels include all tunnels in the router, both active and defined. All tunnels include all tunnels configured on this interface, both active and defined. Active tunnels are those that are currently active; defined tunnels are defined but not active.

Syntax:

list ... all
global
tunnel
active *tunnel-id tunnel-name* all
defined *tunnel-id tunnel-name* all

Example 1: Listing all active tunnels

```
IPsec>li tunnel ?
ACTIVE
DEFINED
IPsec>li tunnel active
Enter the Tunnel ID, Tunnel Name, or 'ALL' [ALL]? all

Tunnel Cache:

 ID     Local IP Addr   Remote IP Addr   Mode   Policy  Tunnel Expiration
-----  --------------  ---------------  -----  ------  ------------------
    2          1.1.1.1          1.1.1.3  TRANS  ESP     **********
    1          1.1.1.1          2.1.1.1  TUNN   AH      **********
```

Example 2: Listing one active tunnel that has received a “packet too big” message.

```
IPsec>li tun act 1

Tunnel      Name       Mode  Policy  Life  Replay       Tunnel       PMTU
  ID                                       Prev      Expiration
------ --------------- ----- ------ ------ ------ ------------------ -----
     1 tofran2         TUNN  AH      46080   No   10:49  May  8 1998 1420 1

Local Information:

      IP Address: 2001:1::6101 2
      Authentication:  SPI:   257    Algorithm: HMAC-MD5
      Encryption:  SPI: -----    Encryption Algorithm: --------
                                 Extra Pad: ---
                                 ESP Authentication Algorithm: ----------
Remote Information:

      IP Address: 2001.1..86
  Authentication:  SPI:   257    Algorithm: HMAC-MD5
```

```
      Encryption:  SPI: -----    Encryption Algorithm: --------
                                 Verify Pad?: ---
                                 ESP Authentication Algorithm: ----------
```

1 PMTU is displayed as n/a if no packet too big has been received.

2 This is an IPv6 address. If the IP version is IPv4, a message is displayed that defines the handling of the DF bit: COPY, SET, or CLEAR.

Example 3: Listing all tunnels

```
IPsec>li all

IPsec is ENABLED

IPsec Path MTU Aging Timer is 30 minutes

Defined Manual Tunnels for IPv4:
--------------------------------------------------------------------------------
   ID         Name         Local IP Addr   Remote IP Addr   Mode    State
 ------  ---------------  ---------------  ---------------  -----  --------

Defined Manual Tunnels for IPv6:
--------------------------------------------------------------------------------
ID=       1  Name= tofran2           Mode= TUNN    State= Enabled
Local IP address=  2001:1::6101
Remote IP address= 2001:1::86


Tunnel Cache for IPv4:
--------------------------------------------------------------------------------
 ID     Local IP Addr   Remote IP Addr   Mode   Policy  Tunnel Expiration
-----  ---------------  ---------------  -----  ------  ------------------

Tunnel Cache for IPv6:
--------------------------------------------------------------------------------
ID=     1  Mode= TUNN   Policy= AH      Expiration= 10:49  May  8 1998
Local IP Address= 2001:1::6101
Remote IP Address= 2001:1::86
```

Reset

Use the **reset** command to dynamically reset IP security on the router or on a single tunnel. After you reset IPsec or the tunnels, be sure to use the **reset IP** command to reset the IP configuration. This is necessary to reload the access control information, such as packet filters and their access control rules. If you do not reset IP, the packet filters and access control rules may not support your new IPsec configuration.

Rebooting the router is an alternative to using the **reset** commands. However, rebooting the router takes it off the network for a time, whereas the **reset** commands interrupt only IP functions.

Syntax:

reset ipsec

tunnel *tunnel-id tunnel-name* all

ipsec Resets IP security on the 2212. IP security is temporarily disabled and then restarted. While IP security is disabled, any packets that are normally handled by IPsec tunnels are dropped until the reset is complete. Resetting IP security does not affect other functions on the 2212. This command activates the IP security configuration that was created using Talk 6. The Talk 6 IP security configuration overwrites the Talk 5 configuration.

tunnel Resets IP security on a specified tunnel. If the tunnel is disabled at the time

of reset, the tunnel configuration is rebuilt from the SRAM configuration, but the tunnel remains disabled after the reset.

tunnel-id
Specifies the identifier of the secure tunnel to be reset.

Valid Values: 1 - 65535

Default Value: 1

tunnel-name
Specifies the name of the secure tunnel to be reset.

Valid Values: any configured tunnel name

Default Value: none

all All tunnels.

Restart

Use the **restart** command to dynamically restart IP security on the router or on a single tunnel. This restarts the temporary configuration that was created using Talk 5. The Talk 6 IP security configuration does not overwrite the Talk 5 configuration.

Syntax:

restart ipsec
tunnel *tunnel-id tunnel-name* all

ipsec Restarts IP security on the 2212.

tunnel Restarts IP security on a specified tunnel.

tunnel-id
Specifies the identifier of the secure tunnel to be reset.

Valid Values: 1 - 65535

Default Value: 1

tunnel-name
Specifies the name of the secure tunnel to be reset.

Valid Values: any configured tunnel name

Default Value: none

all All tunnels.

Set

Dynamically sets the Path MTU (PMTU) aging timer.

Syntax:

set ... path

See the Talk 6 **set** command on page 193 for a description of *path-MTU-aging-timer*.

Stats

Use the **stats** command to display statistics about a specific tunnel or all tunnels. For example, the **stats** command shows packets sent and received.

Syntax:

stats *tunnel-id tunnel-name* **all**

tunnel-id
Specifies the identifier of the secure tunnel.

Valid Values: 1 - 65535

Default Value: 1

tunnel-name
Specifies the name of a secure tunnel that has been configured.

Valid Values: any configured tunnel name

Default Value: none

all Displays statistics about all tunnels configured on the 2212.

Example:

```
IPsec>stats
Enter the Tunnel ID, Tunnel Name, or 'ALL' [ALL]? all

                           Global IPSec Statistics
Received:
  total pkts   AH packets   ESP packets   total bytes    AH bytes     ESP bytes
  ----------   ----------   -----------   -----------   ----------   ----------
           0            0             0             0            0            0

Sent:
  total pkts   AH packets   ESP packets   total bytes    AH bytes     ESP bytes
  ----------   ----------   -----------   -----------   ----------   ----------
           0            0             0             0            0            0

Receive Packet Errors:
  total errs    AH errors   AH bad seq   ESP errors   ESP bad seq
  ----------   ----------   ----------   ----------   -----------
           0            0            0            0             0

Send Packet Errors:
  total errs    AH errors   ESP errors
  ----------   ----------   ----------
           0            0            0
```

IP Security Monitoring Commands (Talk 5)

Chapter 17. Using Layer 2 Tunneling Protocol (L2TP)

Layer Two Tunneling Protocol (L2TP) is a IETF proposed standard protocol for tunneling of PPP across a packet oriented data network such as UDP/IP. L2TP is connection oriented.

Overview of L2TP

L2TP allows many separate and autonomous protocol domains to share a common access infrastructure including modems, Access Servers, and ISDN routers. L2TP permits the tunneling of the PPP link layer, for example, HDLC and asynchronous HDLC. Using these tunnels, it is possible to disassociate the location of the contacted dial-up server from the location that provides access to the network.

Traditionally, dial-up network service on the Internet is provided for registered IP addresses only. L2TP defines a new class of virtual dial-up application that allows multiple protocols and unregistered IP addresses on the Internet. This class of network application is useful for supporting privately addressed IP, IPX, and AppleTalk dial-ups through PPP across an existing Internet infrastructure.

The support of these multiprotocol virtual dial-up applications is beneficial to end users, enterprises, and Internet service providers because it allows the sharing of significant investments in access and core infrastructure and allows end users to use local calls when accessing the services.

L2TP also enables the secure use of existing investments in non-IP protocol applications within the existing Internet infrastructure.

Figure 17 shows a sample L2TP network using ISDN. The network could use any media type between the L2TP Network Access Concentrator (LAC) and the L2TP Network Server (LNS).

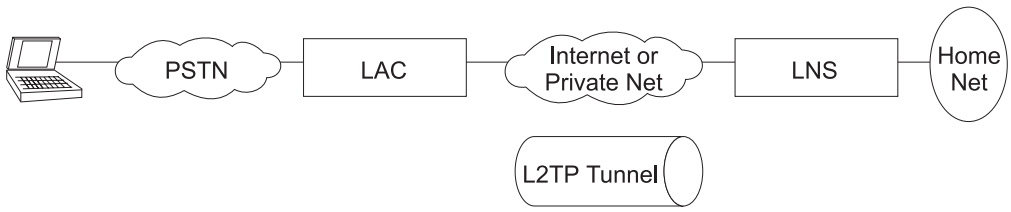


Figure 17. Sample L2TP Network

L2TP Terms

The following terms are used when describing L2TP:

Attribute Value Pair (AVP)
A uniform method of encoding message types and bodies. This method maximizes the extensibility while permitting interoperability of L2TP.

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 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 that can be a PPP end station. The LNS handles the server side of the L2TP protocol. Because L2TP relies only on the single media over which L2TP tunnels arrive, the LNS can have only a single LAN or WAN interface, yet is still able to terminate calls arriving from any PPP interfaces supported by an LAC.

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.

Session (Call)
L2TP creates a session when an end-to-end PPP connection is attempted between a dial user and the LNS. 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.

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.

Supported Features

L2TP runs over UDP/IP and supports the following functions:

- Tunneling of single user dial-in clients
- Tunneling of small routers, for example a router with a single static route to set up based on an authenticated user's profile
- Calls can be initiated from the LAC to the LNS (inbound), from the LNS to the LAC (outbound), or by either peer (both). The outbound calls can be over a fixed L2TP session or a dial-on-demand L2TP session.
- Multiple calls per tunnel
- Proxy Authentication for PAP, CHAP and MS-CHAP
- Proxy LCP
- LCP restart in the event that Proxy LCP is not used at the LAC
- Tunnel end-point authentication
- Hidden AVP for transmitting a proxy PAP password
- Tunneling using a local rhelm (that is, user@rhelm) lookup table
- Tunneling using the PPP username lookup in the AAA subsystem
- Management of L2TP tunnels using SNMP. See "SNMP Management" in the *Protocol Configuration and Monitoring Reference Volume 1*.

Note: Rhelm tunneling requires usernames in *name@rhelm* format. Tunneling this way requires the software to look through two tables to resolve the destination to which the dial-in user is tunnelled. The advantage of using this method of tunneling is that you need only define the rhelm and any usernames that match the rhelm will be tunnelled to the same destination.

User-based tunneling is resolved in a single table. It allows you the granularity of tunneling each user to a unique destination.

- BRS for an LNS (as a PPP end point)
- The ability to use the **delete interface** command to delete L2TP devices
- The ability to dynamically reconfigure L2TP devices
- Establishment of a sequencing, queueing, retransmission and flow control channel. L2TP also performs sequencing, queuing and flow control on data channels.
- The ability to set the L2TP UDP port so you can establish IP security filters based on the UDP port.
- An L2TP router client. L2TP router client is a “client initiated” (also known as voluntary tunneling) model. This function provides secure, tunneled, multi-protocol Virtual Private Network (VPN) services regardless of service provider topology. This function brings the client and LAC into one physical piece of hardware.
- Connection of an inbound call to the appropriate tunnel based on a remote hostname match. If the remote hostname does not match any of the tunnels configured for hostname matching, the call is completed on an inbound net that does not use remote hostname matching.

  Note: If you have configured multiple net mappings between the same LAC and LNS pair, make sure only one tunnel exists for each mapping.
- Automatic IP, IPX, and bridging configuration of inbound nets that do not use remote hostname matching. You must manually configure outbound nets and inbound nets that use remote hostname matching.

Timing Considerations

The nature of tunneling PPP packets over routed networks creates some timing issues that you should consider. L2TP assumes that the connection between the LAC and LNS does not have a delay that is long enough to time out the tunneled peers. If the inter-peer latency repeatedly reaches or exceeds that of the PPP state machine’s timeout (usually 3 seconds), then connectivity could be hindered. Note that if the latency between the LAC and LNS is this poor, then connectivity in general is so poor that the connection will be unreasonable even if the PPP state machines were kept alive artificially. If both sides possess the capability, then the PPP timeout may be extended to achieving connectivity over a very poor connection.

Besides latency, a bandwidth mismatch between the LAC/LNS pair and LAC/Client pair may cause problems. For instance, if the actual bandwidth between the LAC and LNS is significantly less than the bandwidth of the PPP client, then the LAC may spend significant time trying to send packets to the LNS. On the other hand, if the connection between the LNS and a host on the LNS home network is exceptionally fast compared with the dial-in client, then the LNS may be overburdened trying to send data to the LAC. L2TP implements a series of internal and external flow control techniques in an attempt to combat these situations.

LCP Considerations

When using Proxy LCP, the LAC negotiates LCP and PPP continues processing at the LNS. The LAC forwards LCP options to the LNS so that the LNS is aware of what was negotiated. The LNS must remain flexible to the parameters negotiated by the client and LAC. If there are any parameters that are unacceptable to the LNS, then L2TP attempts to renegotiate LCP by sending an *LCP Configure Request* to the client across the tunnel.

The requirement for the LNS to remain flexible is of particular concern regarding the MRU. On the IBM LNS, the configured MRU is the maximum allowed for Proxy LCP. If the value in the Proxy LCP message from a LAC is greater than the MRU configured on the LNS, then L2TP will attempt to renegotiate LCP with an MRU equal to the configured MRU without changing other LCP options from the LAC.

Configuring L2TP

To configure L2TP:

1. Access the L2TP feature using the **feature** command.

```
Config> feature layer-2-tunneling
Layer-2-Tunneling config>
```

2. Enable L2TP.

```
Layer-2-Tunneling config> enable l2tp
```

3. Add any L2TP networks needed. If this is to be strictly an LAC, you will not have to add any L2TP nets.

```
Layer-2-Tunneling Config>ADD L2-NETS
Additional L2 nets:  [0]? 10
Add unnumbered IP addresses for each L2 net? [Yes]: yes
Adding device as interface 31
Defaulting Data-link protocol to PPP
Adding device as interface 32
Defaulting Data-link protocol to PPP
Adding device as interface 33
Defaulting Data-link protocol to PPP
Adding device as interface 34
Defaulting Data-link protocol to PPP
Adding device as interface 35
Defaulting Data-link protocol to PPP
Adding device as interface 36
Defaulting Data-link protocol to PPP
Adding device as interface 37
Defaulting Data-link protocol to PPP
Adding device as interface 38
Defaulting Data-link protocol to PPP
Adding device as interface 39
Defaulting Data-link protocol to PPP
Adding device as interface 40
Defaulting Data-link protocol to PPP
```

4. Configure any inbound L2TP tunnels.

   To configure a tunnel using an AAA local list:

```
Config>add tunnel-profile
Enter name:  []? lns.org
Enter hostname to use when connecting to this peer: []? lac.org
set shared secret? (Yes, No): [No] Y
Shared secret for tunnel authentication:
Enter again to verify:
Tunnel-Server endpoint address: [0.0.0.0]? 11.0.0.1

      PPP user name: lns.org
      Tunnel Server: 11.0.0.1
      Hostname: lac.org

 User 'lns.org' has been added
 Config>
```

You can use the previous example to configure tunnel authorization on the LAC as well as “rhelm” tunneling in the form of “user@lns.org.”

You can set tunnel authentication and authorization to be done at a particular RADIUS server. See “Using Authentication, Authorization, and Accounting (AAA) Security” in *Using and Configuring Features*.

To tunnel by PPP username on a LAC using either an AAA local list or RADIUS:

```
Config>add ppp-user
Enter name:  []? peter
Password:
Enter again to verify:
Will 'peter' be tunneled? (Yes, No): [No] Y
Enter hostname to use when connecting to this peer: []? lac.org
Tunnel-Server endpoint address: [0.0.0.0]? 11.0.0.1

     PPP user name: peter
     Tunnel Server: 11.0.0.1
     Hostname: lac.org

Is information correct? (Yes, No, Quit): [Yes]

User 'peter' has been added
Config>
```

Configure remote hostname matching for the inbound tunnels, if required. Assuming that the previous configuration was for net 10:

```
Config> net 10
     L2TP 10> set remote-hostname
     Remote Tunnel Hostname: [] ibm.com
```

Note: To turn off remote hostname matching, use the following commands:

```
Config> net 10
     L2TP 10> set any-remote-hostname
```

5. Configure any L2TP outbound (or both) tunnels. The following example shows a LAC with IP address 1.1.1.1 and an LNS with IP address 1.1.1.2. The LNS is configured to place a dial-on-demand ISDN call to 5552160 from the LAC.

   LNS Configuration:

```
Config> add tunnel-profile
     Enter name:  []? lac.org
     Enter hostname to use when connecting to this peer: []? lns.org
     set shared secret? (Yes, No): [No] Y
     Shared secret for tunnel authentication:
     Enter again to verify:
     Tunnel-Server endpoint address: [0.0.0.0]? 1.1.1.1

            Tunnel name: lac.org
               Endpoint: 1.1.1.1
               Hostname: lns.org

     User 'lac.org' has been added
     Config>
     Config> add dev layer-2-tunneling
     Config> net 10
     L2TP 10> set connection-direction outbound
     L2TP 10> set idle 30
     L2TP 10> set remote-hostname lac.org
     L2TP 10> enable outbound-call-from-lac
        Outbound Call Type (ISDN, V34)? [ISDN]
        Outbound calling address: 5552160
        Outbound calling subaddress:
     L2TP 10>
     L2TP 10> encapsulator
```

```
PPP 10> set name vickie 1
L2TP 10>
L2TP 10> exit
Config> add ppp-user larry 2
```

Notes:

a. Set authentication name in case the LNS device is authenticated. There are additional prompts that are not shown in this example. For details see, "Configuring PPP Authentication" in the *Access Integration Services Software User's Guide*.

b. Add users to be authenticated at the LNS. There are additional prompts that are not shown in this example. See Add in the chapter "Configuring the CONFIG Process" in *Access Integration Services Software User's Guide* for a description of the command syntax and options.

LAC Configuration:

```
Config> add tunnel-profile
     Enter name:  []? lns.org
     Enter hostname to use when connecting to this peer: []? lac.org
     set shared secret? (Yes, No): [No] Y
     Shared secret for tunnel authentication:
     Enter again to verify:
     Tunnel-Server endpoint address: [0.0.0.0]? 1.1.1.2

            Tunnel name: lns.org
               Endpoint: 1.1.1.1
               Hostname: lac.org

     User 'lns.org' has been added
     Config>
     Config> add dev dial-in 1
```

Notes:

a. Used to place the physical call.

6. Configure any L2TP router clients. The following example shows an L2TP box-to-box connection using the L2TP router client function. This connection is set in one direction and is dial-on-demand.

LNS Configuration:

```
Config> add tunnel-profile
     Enter name:  []? lac.org
     Enter hostname to use when connecting to this peer: []? lns.org
     set shared secret? (Yes, No): [No] Y
     Shared secret for tunnel authentication:
     Enter again to verify:
     Tunnel-Server endpoint address: [0.0.0.0]? 1.1.1.1

            Tunnel name: lac.org
               Endpoint: 1.1.1.1
               Hostname: lns.org

     User 'lac.org' has been added
     Config>
     Config> add dev layer-2-tunneling
     Config> net 10
     L2TP 10> set connection-direction outbound
     L2TP 10> set idle 30
     L2TP 10> set remote-hostname lac.org
     L2TP 10> encapsulator
     PPP 10> set name donald  1
     PPP 10> exit
```

```
L2TP 10> exit
Config>
Config> add ppp-user bruce 2
Config>
```

Notes:

a. Set authentication name in case the LNS device is authenticated. There are additional prompts that are not shown in this example. For details see, "Configuring PPP Authentication" in the *Access Integration Services Software User's Guide*.

b. Add users to be authenticated at the LNS. There are additional prompts that are not shown in this example. See Add in the chapter "Configuring the CONFIG Process" in *Access Integration Services Software User's Guide* for a description of the command syntax and options.

LAC Configuration:

```
Config> add tunnel-profile
     Enter name:  []? lns.org
     Enter hostname to use when connecting to this peer: []? lac.org
     set shared secret? (Yes, No): [No] Y
     Shared secret for tunnel authentication:
     Enter again to verify:
     Tunnel-Server endpoint address: [0.0.0.0]? 1.1.1.2

            Tunnel name: lns.org
               Endpoint: 1.1.1.1
               Hostname: lac.org

     User 'lns.org' has been added
     Config>
     Config> add dev layer-2-tunneling
     Config> net 10
     L2TP 10> set connection-direction inbound
     L2TP 10> set idle 30
     L2TP 10> set remote-hostname lns.org
     L2TP 10> encapsulator
     PPP 10> set name bruce 1
     PPP 10> exit
     L2TP 10> exit
     Config>
     Config> add ppp-user donald 2
     Config>
```

Notes:

a. Set authentication name in case the LNS device is authenticated. There are additional prompts that are not shown in this example. For details see, "Configuring PPP Authentication" in the *Access Integration Services Software User's Guide*.

b. Add users to be authenticated at the LNS. There are additional prompts that are not shown in this example. For details see, "**add** Config command" in the *Access Integration Services Software User's Guide* .

7. Configure the various L2TP parameters using the **set** command, if desired.
8. Configure the PPP parameters for all of the L2 nets using the encapsulator command, if desired.

```
Layer-2-Tunneling Config>encapsulator
PPP-L2TP Config>
```

When you have completed the PPP configuration, enter **exit** to return to the L2TP configuration environment.

9. Enable any L2TP functions using the **enable** command.

Chapter 18. Configuring and Monitoring L2TP

This chapter describes the L2TP Protocol configuration and operational commands. Sections in this chapter include:

L2TP Configuration Commands

Table 35 summarizes the L2TP configuration commands and the rest of this section explains the commands. Enter these commands at the `L2TP Config>` prompt.

Table 35. L2TP 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 xxvi.
Add	Adds L2TP nets or peers.
Delete	Deletes L2TP peers from the configuration.
Disable	Disables L2TP.
Enable	Enables L2TP.
Encapsulator	Allows you to configure PPP parameters for all of the L2TP nets.
List	Displays information about the L2TP configuration.
Set	Allows you to set buffers, the call receive window, and other L2TP parameters.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Add

Use the **add** command to add an L2TP peer (LAC or LNS) or an L2-Net. One L2-Net is required for each concurrent PPP session that ends on this router. The end of a tunneled PPP session is the LNS end point of the tunnel.

Syntax: **add**
L2-nets

"Configuring L2TP" on page 204 contains an example of the **add** command.

L2-nets

Note: This command can be entered entirely in lower case. The initial character is shown in upper case for clarity.

Adds an L2-Net to the L2TP configuration. One L2-Net is required for each concurrent PPP session that is to be terminated at this router. If this router is to be used strictly as an LAC, no virtual L2-Nets are necessary. When you enter this command, you are prompted for the number of additional nets and whether to add unnumbered IP addresses for each L2 net.

The number of additional nets refers to how many nets L2TP automatically adds at this time. These nets are in addition to any L2-Nets that may already exist.

Adding unnumbered IP addresses for each L2-Net automatically add unnumbered IP entries into the IP routing table for each of the L2-Nets. Unnumbered IP addresses are the preferred mode of operation. If you need numbered addresses for the L2-Nets, you can alter them in the IP protocol configuration environment (refer to the chapter entitled “Configuring IP” in the *Protocol Configuration and Monitoring Reference Volume 1*).

Disable

Use the **disable** command to disable L2TP functions or disable L2TP itself.

Syntax: disable
- call-rcv-window
- fixed-udp-source-port
- force-chap-challenge
- hiding-for-pap-attributes
- L2tp
- outbound-call-from-lac
- proxy-auth
- proxy-lcp
- tunnel-authentication

call-rcv-window
L2TP can queue packets for each call in order to perform sequencing and congestion control. Each call has its own queue, or window, whose size must be transmitted to the peer for the flow control algorithms to work correctly. Disabling the *call-rcv-window* turns off all flow control for each session. This may be desirable when the connection between the LAC and LNS is known to be of high quality, sufficient bandwidth, and not prone to a great deal of packet reordering.

fixed-udp-source-port
Clears the L2TP UDP port setting. Disabling this parameter forces you to configure IP security filters between the LAC and the LNS by IP address.

force-chap-challenge
Disables the LNS CHAP rechallenge of a client. You may need to disable the CHAP rechallenge if the PPP client has difficulty with CHAP rechallenges.

hiding-for-pap-attributes
Disables the encryption of Proxy PAP information between the LAC and LNS.

L2tp

Note: This command can be entered entirely in lower case. The initial character is shown in upper case for clarity.

Disables L2TP on this router.

outbound-calls-from-lac
Prevents a LAC from placing a call to initiate an L2TP tunnel.

proxy-auth
Disables sending PPP proxy-authentication from LAC to LNS.

proxy-lcp
Disables sending LCP information from LAC to LNS.

tunnel-authentication
Disables peer authentication based on a shared secret for all tunnels.

Enable

Use the **enable** command to enable L2TP functions or enable L2TP itself.

Syntax:

enable
- fixed-udp-source-port
- force-chap-challenge
- hiding-for-pap-attributes
- L2tp
- outbound-call-from-lac
- proxy-auth
- proxy-lcp
- tunnel-authentication

fixed-udp-source-port
Sets the L2TP UDP port at 1701. Enabling this parameter allows you to configure IP security filters by UDP port for L2TP so you can encrypt or authenticate L2TP traffic easily.

force-chap-challenge
Enables the LNS CHAP rechallenge of a client even if the LNS receives a proxy CHAP. This is preferable from a security standpoint, if it is known that the client can handle such a rechallenge without problems.

hiding-for-pap-attributes
Enables the encryption of Proxy PAP information between the LAC and LNS.

outbound-calls-from-lac
Allows a LAC to place a call to initiate an L2TP tunnel. The software prompts you for session parameters.

Example:

```
L2TP 10> enable outbound-call-from-lac
        Outbound Call Type (ISDN, V34)? [ISDN]
        Outbound calling address: 1234
        Outbound calling subaddress:
L2TP 10>
```

L2tp

Note: This command can be entered entirely in lower case. The initial character is shown in upper case for clarity.

Enables L2TP on this router.

proxy-auth
Enables sending PPP proxy-authentication from LAC to LNS.

proxy-lcp
Enables sending LCP information from LAC to LNS.

tunnel authentication
Enables peer authentication based on a shared secret for all tunnels.

Encapsulator

Use the **encapsulator** command to configure the PPP parameters for the L2-Nets.

Syntax: encapsulator

List

Use the **list** command to display the state of the various L2TP configuration parameters.

Syntax: list

```
Layer-2-Tunneling Config>list
GENERAL ADMINISTRATION
------- --------------
  L2TP                                = Enabled
  Maximum number of tunnels           = 20
  Maximum number of calls (total)     = 50
  Buffers Requested                   = 300

CONTROL CHANNEL SETTINGS
------- ------- --------
  Tunnel Auth                         = Enabled
  Tunnel Rcv Window                   = 4
  Retransmit Retries                  = 6
DATA CHANNEL SETTINGS
---- ------- --------
  Force CHAP Challenge (extra security)= Disabled
  Hiding for PAP Attributes           = Disabled
  Call Rcv Window                     = 6

MISCELLANEOUS
-------------
  SEND PROXY-LCP FROM LAC             = Enabled
  SEND PROXY-AUTH FROM LAC            = Enabled
```

Set

Use the set command to configure the L2TP operational parameters.

Syntax: set any-remote-hostname
buffers
call-rcv-window
connection-direction
idle
max-calls
max-tunnels
remote-hostname
transmit-retries
tunnel-rcv-window

any-remote-hostname
Clears the outbound remote hostname and disables inbound remote host name matching on this net.

buffers

Specifies the number of requested internal L2TP buffers. If there is not enough memory to satisfy the request, only a portion of the buffers will be available upon reboot. To confirm the amount of memory while L2TP is active, use the **memory** command (see “Memory” on page 217).

Valid values: 1 to 1000

Default value: 200

call-rcv-window

Specifies the number of packets to be used as a receive window and enables the call-rcv-window. If flow control is enabled on the data channel, a receive window size must be designated, both for use by the protocol on this router and for communication to the peer using start-up messages. The value configured is for all calls initiated by this router.

Valid values: 0 to 100

Default value: 6

connection-direction [inbound] or [outbound] or [both]

Specifies whether the connection can be initiated by the peer (inbound), the LAC (outbound) or either the peer or the LAC (both) on this net. If you specify both, you cannot configure the idle time a 0.

Default value: inbound

idle-time *seconds*

Specifies the number of seconds of inactivity after which L2TP will disconnect the tunnel on this net. A value of 0 indicates that the tunnel is fixed and should not be disconnected.

Valid values: 0 to 1024

Default value: 0

max-calls

Specifies the maximum number of calls across all tunnels that can be active at a given time either as LAC or LNS.

Valid values: 1 to 500

Default value: 100

max-tunnels

Specifies the maximum number of tunnels that can be active at a given time either as LAC or LNS.

Valid values: 1 to 100

Default value: 30

remote-hostname *hostname*

Specifies the remote-hostname used on this tunnel.

For an outbound tunnel, the hostname is sent to the peer when placing a call. The peer uses this hostname to determine whether the call should be completed. This hostname must be configured in the authentication subsystem for calls to complete successfully. See “Chapter 12. Using Local or Remote Authentication” on page 143 for more information.

For an inbound tunnel, the hostname is used to verify whether a call received from a peer on this tunnel should be completed.

Valid values: Any name from 1 to 64 ASCII characters

Default value: None

transmit-retries
Specifies the number of times a packet is retransmitted on the control channel before the session or tunnel is declared inactive and is shut down.

Valid values: 2 to 100

Default value: 6

tunnel-rcv-window
Specifies the receive window size for the reliable control connections transport. This transport transmits and receives the messages necessary for tunnel or session setup, tear down, and maintenance.

Valid values: 1 to 100

Default value: 4

Accessing the L2TP Monitoring Prompt

To access the L2TP monitoring prompt:

1. Enter **talk 5** at the OPCON (*) prompt.
2. Enter **feature layer-2-tunneling** at the GWCON (+) prompt.

L2TP Monitoring Commands

This section summarizes and then describes the L2TP monitoring commands. Enter the commands at the `Layer-2-Tunneling Console>` prompt.

Table 36 summarizes the L2TP monitoring commands.

Table 36. L2TP 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 xxvi.
Call	Displays statistics and information about each call in progress.
Kill	Ends a call or tunnel immediately.
Memory	Displays the current L2TP buffer allocation and use.
Start	Starts a tunnel with another peer.
Stop	Stops a call or tunnel and allows each peer to perform any needed administration.
Tunnel	Displays statistics and information on each existing tunnel.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Call

Use the **call** command to display call statistics and information.

Syntax: call errors
physical-errors
queue
state

statistics

errors Displays the general transmission errors that occurred on the calls.

Example:

```
Layer-2-Tunneling Console> call errors
CallID | Serial # | ACK-timeout | Dropped pkts
 56744 |        1 |           0 |          0
```

CallID The local identifier associated with this call.

Serial #
The number used for logging this call.

ACK-timeout
The number of times a timeout notification has been received from the peer.

Dropped pkts
The number of packets that have been declared lost for this call. These are packets which should have been received, but were signalled as lost by the peer.

physical-errors
Displays the data errors that occurred on the calls.

Example:

```
Layer-2-Tunneling Console> call physical-errors
CallID | Serial# | CRC    |framing|   HW    | buffer|timeout| align-| time since
       |         | Errors| Errors|overrun|overrun| Errors|  ment  | updated
 56744 |       1 |     0 |     0 |     0 |     0 |     0 |     0 |
```

CallID The local identifier associated with this call.

Serial #
The number used for logging this call.

CRC Errors
The number of packets on which the CRC did not match.

framing errors
The number of packets with a framing error.

HW overrun
The number of times a hardware overrun occurred.

buffer overrun
The number of times a buffer overrun occurred.

timeout errors
The number of times an interface timed out.

alignment
The number of times an alignment error occurred.

time since updated
The elapsed time since last poll for errors.

queue Displays information about the queue for each call.

Example:

```
Layer-2-Tunneling Console> call queue
CallID | Serial # |Tx Win|Rx Win|   Ns   |   Nr   |Rx Q|Tx Q|priority| out Q
 56744 |        1 |    4 |    4 |    100 |   200  |  0 |  0 |      0 |     0
```

CallID The local identifier associated with this call.

Serial #
The number used for logging this call.

Tx Win
The peer's maximum receive window for data.

Rx Win
The local maximum transmit window.

Ns The next packet sequence number to send for this call.

Nr The next packet sequence number expected to be received for this call.

Rx Q The current number of packets on the receive queue.

Tx Q The current number of packets on the transmit queue.

priority
The number of priority PPP packets waiting to be transmitted by L2TP.

out Q The number of regular PPP packets waiting to be transmitted by L2TP.

state Displays the current state of each call.

Example:

```
Layer-2-Tunneling Console> call state
CallID │ Serial # │ Net #  │    State    │ Time Since Chg │ PeerID │ TunnelID
 56744 │        1 │      2 │ Established │   00:00:00     │  345   │ 45678
```

CallID The local identifier associated with this call.

Serial #
The number used for logging this call.

Net # The device number associated with this call. For an LNS call, this is the L2-Net. For an LAC call, this is the PPP device that received the initial call.

State The current call state. Valid call states are:

Established
Ready for tunneled network traffic.

Idle The call is idle.

Wait Cs Answer
Waiting for the communication link to open.

Wait Reply
Waiting for a reply from the peer.

Wait Tunnel
Waiting for tunnel establishment.

Time since chg
The elapsed time since the last state change.

PeerID
The Peer's call ID.

TunnelID
The local tunnel associated with this call.

statistics
Displays statistics about the data transmission for each call.

Example:

```
Layer-2-Tunneling Console> call statistics
CallID | Serial # | Tx Pkts | Tx Bytes | Rx Pkts | Rx Bytes |  RTT  | ATO
 56744 |        1 |      34 |     1056 |      45 |     1567 |   10  | 34
```

CallID The local identifier associated with this call.

Serial #
The number used for logging this call.

Tx Pkts
The number of packets transmitted for this call.

Tx Bytes
The number of bytes transmitted for this call.

Rx Pkts
The number of packets received for this call.

Rx Bytes
The number of bytes received for this call.

RTT The currently calculated round trip time for this call.

ATO The currently calculated adaptive time out for this call.

Kill

Use the **kill** to immediately end a tunnel. This command releases all of the local resources for a tunnel thereby forcing the end of the connection. No notification of the end of the tunnel is sent to the peer.

Note: Use this command only if the **stop** command is unable to end a tunnel.

Syntax: kill tunnel *tunnelid*

tunnel *tunnelid*
Specifies the tunnel to end.

Memory

Use the **memory** command to display L2TP's current memory utilization.

Syntax: memory

Example:

```
Layer-2-Tunneling Console> mem
Number of layer-2-tunneling buffers: Requested = 2000, Total = 1200, Free
= 1000
```

In this example, you configured 2000 buffers but were able to allocate only 1200. Currently, 200 buffers are in use leaving 1000 free.

Start

Use the **start** command to start a tunnel with another peer.

Syntax: start (no parameters will prompt for hostname)

tunnel *hostname*

hostname
The name of the host with which L2TP establishes the tunnel.

Stop

Use the **stop** command to stop a tunnel. Any required cleanup is completed before the tunnel ends.

Syntax: stop tunnel *tunnelid*

tunnel *tunnelid*
Specifies the tunnel to end.

Tunnel

Use the **tunnel** command to display statistics and information about all tunnels.

Syntax: tunnel
call
errors
peer
queue
state
statistics
transport

calls Displays all tunnels and the call state for each call within each tunnel.

errors Displays the errors that have occurred on a tunnel.

Example:

```
Layer-2-Tunneling Console> tunnel errors
Tunnel ID │ Type │ACK-timeouts
 96785    │ L2TP │    0
```

Tunnel ID
The local identifier associated with a tunnel.

Retransmissions
The number of packets that were retransmitted on the tunnel.

peer Displays the tunnels and the peers associated with the tunnels.

Example:

```
Layer-2-Tunneling Console> tunnel peer
Tunnel ID │ Type │ Peer ID │ Peer Hostname
 96785    │ L2TP │   89777 │ mypeer
```

Tunnel ID
The local identifier associated with a tunnel.

Peer ID
The peer's tunnel identifier assigned to this tunnel.

Peer Hostname
The hostname of the peer as it appears in the local database.

queue Displays information about the queue for each tunnel.

Example:

```
Layer-2-Tunneling Console> tunnel queue
Tunnel ID │ Type │ Rx Win │ Tx Win │   Ns   │   Nr   │ Rx Q │  Tx Q
 96785    │ L2TP │      4 │      4 │      5 │      6 │    0 │     0
```

Tunnel ID
The local identifier associated with a tunnel.

Rx Win
The local maximum number of packets that constitute the receive window.

Tx Win
The peer's maximum number of packets that constitute the receive window.

Ns The sequence number of the next packet to send.

Nr The sequence number of the next packet to receive.

Rx Q The number of packets currently on the receive queue.

Tx Q The number of packets currently on the transmit queue.

state Displays the current state of all the tunnels.

Example:

```
Layer-2-Tunneling Console> tunnel state
Tunnel ID │ Type │ Peer ID │     State     │ Time Since Chg │ # Calls │ Flags
 96785    │ L2TP │  89777  │ Established │    00:00:00    │       1 │  0
```

Tunnel ID
The local identifier associated with a tunnel.

Peer ID
The peer's tunnel identifier assigned to this tunnel.

State The current tunnel state. Valid tunnel states are:

Established
The tunnel is established.

Idle The tunnel is idle.

Wait Ctrl Reply
The host is waiting for a reply from the peer.

Wait Ctrl Conn
The host is waiting for a connection indication.

Time since chg
The elapsed time since the last state change.

 # Calls
The number of active calls on this tunnel.

Flags The flags used to control the connection messages on this tunnel.

statistics
Displays the statistics associated with the tunnels.

Example:

```
Layer-2-Tunneling Console> tunnel statistics
Tunnel ID │ Type │ Tx Pkts │ Tx Bytes │ Rx Pkts │ Rx Bytes │  RTT  │ ATO
 96785    │ L2TP │       4 │       78 │       5 │       89 │    10 │ 31
```

Tunnel ID
The local identifier associated with a tunnel.

Tx Pkts
The number of packets transmitted.

Tx Bytes
The number of bytes transmitted.

Rx Pkts
The number of packets received.

Rx Bytes
The number of bytes received.

RTT The currently calculated round trip time for tunnel control connection messages.

ATO The currently calculated adaptive timeout for tunnel control connection messages.

transport
Displays UDP information about the tunnels.

Example:

```
Layer-2-Tunneling Console> tunnel transport
Tunnel ID │ Type │ Peer IP Address │ UDP Src │ UDP Dest
 96785    │ L2TP │  11.0.0.102     │  1056   │   1089
```

Tunnel ID
The local identifier associated with a tunnel.

Peer IP address
The peer's IP address for this tunnel.

UDP Src
The UDP source port for this tunnel.

UDP Dest
The UDP destination port for this tunnel.

Chapter 19. Using Network Address Translation

Network Address Translation (NAT) and its extension Network Address and Port Translation (NAPT) can expand the number of IP addresses available to an organization and can prevent users in the public network from becoming aware of some of the addresses in the private network. NAT works by using public IP addresses to represent private IP addresses.

Public IP addresses are the valid addresses of hosts in the IP public network and they must be unique within the public network. If the public network is the Internet, the public IP addresses must be unique Internet addresses provided by the Network Information Center (NIC).

The private addresses are known to the router, but not to the public network. The addresses within each private network must be unique; however, the same address can be duplicated in two different private networks. The private addresses are assigned to hosts within stub networks. Stub networks are networks that have access to the public network through one router only.

NAT expands the number of available IP addresses in several ways:

- It allows each public address to represent multiple private addresses by rotating the use of the public addresses.
- It allows the duplication of addresses as long as each duplicate address is used in a different private network.
- It allows the network administrator to use any IP addresses in the private networks, instead of the NIC addresses that are becoming limited resources.

Using private addresses also hides these addresses from the outside world. This feature of NAT makes it useful as a type of firewall to protect the private addresses from being known.

Important: As stated in section 5.4 of the Internet Draft which defines NAT, “any application that carries (and uses) the IP address (and TCP/UDP port, in the case of NAPT) inside the application will not work through NAT...”. It should be noted that DLSw and XTP make decisions based on the end-point IP addresses — specifically which partner has the higher address. Since the application (such as DLSw or XTP) that is running through NAT thinks that its address is the private address, but the partner application in the other router thinks that the application’s address is the public address, incorrect decisions can be made.

See Figure 18 on page 222 for a drawing of a workstation in a stub network. In this example, the stub network consists of an IP subnet that has the IP address 10.33.96.0 with the subnet mask 255.255.255.0.

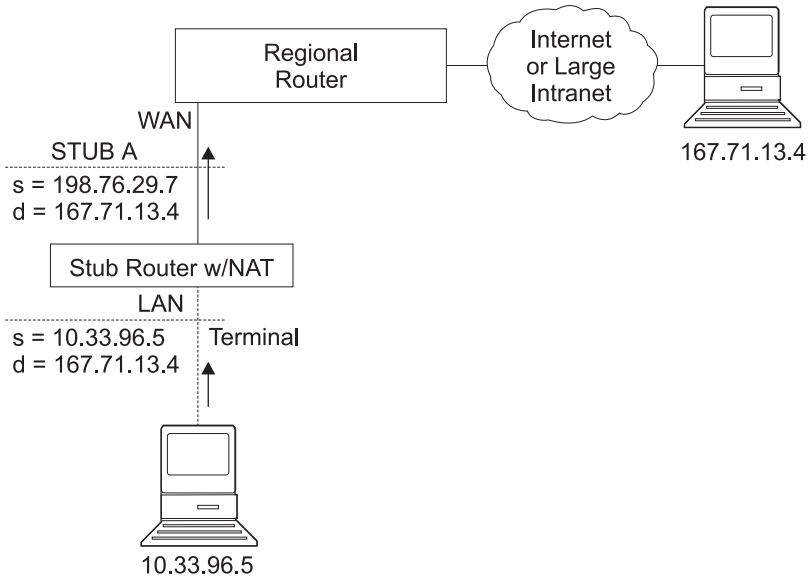


Figure 18. Network Running NAT

To use NAT, the network administrator assigns one or more public IP addresses to a public address pool in the 2212 and assigns a private IP address to each workstation in the stub network. The public IP addresses are assigned to a *reserve pool* and the private IP addresses are assigned to the *translate range*.

The NAT function first binds the private address of a station in the private network to one of the public addresses. Binding means that every packet with that private address will be translated to that public IP address when the packet is outbound. Inbound packets have the public IP address as their destination. NAT recognizes the public address, translates it to the private IP address, and forwards the packet. After traffic stops, the binding is maintained until a timer that you can set times out. At this time, NAT ends the binding and makes the public address available for reuse.

In this example, a packet is transmitted from sending private source address 10.33.96.5 to a destination address in the Internet, 167.71.13.4. NAT in the 2212 translates private address 10.33.96.5 to public address 198.76.29.7. This translation hides the private address 10.33.96.5 from the public network, so that no incoming packet is addressed directly to private address 10.33.96.5. Instead, incoming packets from 167.71.13.4 are addressed to public address 198.76.29.7. When the NAT router receives packets addressed to 198.76.29.7, NAT translates the destination public address to the private address 10.33.96.5 and forwards the packets.

Network Address Port Translation

NAPT can be used only for TCP and UDP traffic. In NAPT, multiple private addresses can use a single public address simultaneously. While NAT maps one public address to one private address, NAPT maps the NAPT public address ***and*** the public port number to a private address and private port number. Only one NAPT address can be configured for each public address pool.

NAPT is configured simply by configuring one public address that will be used for NAPT traffic. The advantage of NAPT is that it can enable one address from the pool of public IP addresses to support many private IP addresses simultaneously.

Static Address Mappings

Sometimes you may want to configure a station or server in the private network that can be directly accessed from the public network. In this case, you should make a static mapping of the private address of the station to a particular public address. All messages outbound from the private address are translated to the designated public address and all messages inbound for the designated public address are automatically forwarded to the associated private address. There are two kinds of static address mappings: NAT and NAPT.

NAT Static Address Mapping

In a NAT mapping, all IP protocols can access the host. This is an example of the configuration of a NAT mapping:

Private address	10.1.1.2
Private port	0
Public NAT address	9.67.1.1
Public port	0

NAPT Static Address Mapping

To specify a TCP or UDP application, you have the option to specify a NAPT mapping that includes a private well-known port. For NAPT static address mapping, a NAPT public address must be configured. For example, to configure a Telnet host at private address 10.1.1.1 to use the NAPT public address 9.67.1.2, the static mapping would be configured as follows:

Private address	10.1.1.1
Private port	23
Public NAPT address	9.67.1.2
Public port	23

The private and public ports are mapped to port 23, which is the well-known port for Telnet. Now, if the administrator also has an FTP server (well-known address 21) at the same private address 10.1.1.1 to map to the NAPT public address 9.67.1.2, that mapping can look like this:

Private address	10.1.1.1
Private port	21
Public NAPT address	9.67.1.2
Public port	21

The server at address 10.1.1.1 has the same NAPT public address (9.67.1.2) for both applications, but NAPT can distinguish between the two by using the different port numbers (23 and 21). However, NAPT cannot distinguish between two servers that use the same NAPT public address and have the same application and port number. For example, if the NAPT public address and well-known port are the

same for 10.1.1.3 port 21 as for 10.1.1.1 port 21, NAPT cannot tell whether to send incoming FTP traffic to server 10.1.1.3 or 10.1.1.1. To configure more than one server with the same NAPT address and application, you must use a port other than the well-known port at the server (for example, start the FTP daemon on port 200).

Setting Packet Filters and Access Control Rules for NAT

In addition to identifying the range of private addresses to be translated by NAT or NAPT, the administrator must set up packet filters and access control rules for IP in the 2212. NAT configuration requires you to configure one inbound and one outbound packet filter on the interface that is connected to the public network. You need to configure one or more access control rules on the inbound packet filter and one or more access control rules on the outbound packet filter. The inbound filter access control rules pass inbound packets with the appropriate defined public addresses to NAT. The outbound filter access control rules pass outbound packets with the appropriate defined private addresses to NAT.

The access control rules that are applied for NAT have the access control rule types ***I*** and ***N*** for inclusive and NAT. Refer to the *Protocol Configuration and Monitoring Reference, Vol. 1* for information about configuring IP access controls.

Note: NAT can also be configured in conjunction with an IPsec tunnel. A sample of this configuration is found in “Configuring Packet Filter Access Control Rules for Router A” on page 178.

Example: Configuration of NAT With IP Filters and Access Control Rules

This example shows how to configure NAT for the stub router in the network pictured in Figure 19. See “Chapter 20. Configuring and Monitoring Network Address Translation” on page 227 for descriptions of the commands.
Follow this procedure:

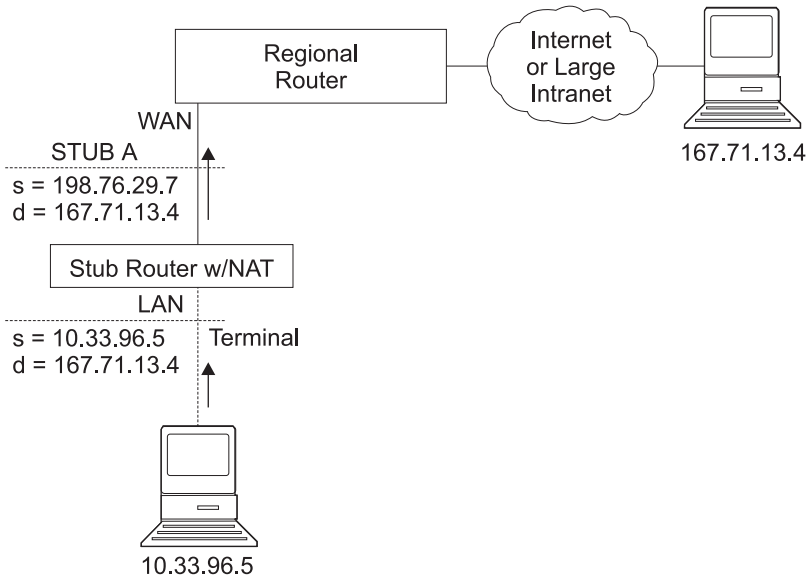


Figure 19. Network Running NAT

1. Set up pools of public addresses for use by NAT and NAPT. To do this, use the **reserve** command.

```
NAT config> reserve 198.76.29.7 255.255.255.0 6 pool1 198.76.29.7
NAT config> reserve 198.76.29.15 255.255.255.0 3 pool1 0.0.0.0
```

   In this example, a pool called *pool1* is established. The NAPT address in the pool is 198.76.29.7. The addresses 198.76.29.13 and 198.76.29.14 are not available, so the pool is set up to exclude them. The parameters entered are: *public-address, mask, number-in-group, name, and napt-address*. The value 0.0.0.0 for the NAPT address means that none of the addresses in this group is the NAPT address. Use 0.0.0.0 for the NAPT address in all groups if you do not configure NAPT for the pool.

2. Use the **translate** command to establish the ranges of private addresses to be translated by the public addresses in pool1. The parameters entered are: *private-address, mask, and name*.

```
NAT config> translate 10.33.96.0 255.255.255.0 pool1
```

3. Set up static mappings for stations inside the private network that are to be permanently mapped to one of the public addresses. The following commands identify one machine (10.33.96.5) that will receive any type of traffic from the public network. A second machine (10.33.96.4) is both a Telnet and an HTTP server. The parameters are *private-address, private-port-number, public-address, and public-port-number*. Note that the NAPT address for pool1 is used as the public address for the host that is configured with two port numbers.

```
NAT config> map 10.33.96.5 0 198.76.29.8 0
NAT config> map 10.33.96.4 23 198.76.29.7 23
NAT config> map 10.33.96.4 80 198.76.29.7 80
```

4. Enable NAT.

```
NAT config> enable NAT
```

5. Create two IP packet filters so that IP will pass packets to NAT. These are inbound and outbound packet filters for interface 0, which is the interface connected to the public network.

```
IP Config> add packet-filter outbound out-0 0
IP Config> add packet-filter inbound in-0 0
```

6. Use the **update** command to bring up the `packet-filter '`*`filter-name`*`' Config>` prompt. Add an access control rule for NAT to the inbound filter. Packets received over the public interface (net 0) that are destined for an address in NAT's reserved public address pool should be passed to NAT. NAT will replace the public address (and the public port if the packet is destined for the NAPT address) with the correct private address (and the private port if the packet is destined for the NAPT address). The 0.0.0.0 address and mask for the Internet source indicate that any source addresses from the public network will be passed to NAT.

```
IP Config>update packet-filter
Packet-filter name [ ]? in-0
Packet-filter 'in-0' Config> add access
Enter type [E]? IN
Internet source [0.0.0.0]?
Source mask [255.255.255.255]? 0.0.0.0
Internet destination [0.0.0.0]? 198.76.29.0
Destination mask [255.255.255.255]?255.255.255.0
Enter starting protocol number ([0] for all protocols) [0]?
Enable logging? (Yes or [No]):
Packet-filter 'in-0' Config>
```

   The range of addresses in the access control rule is greater than the range of addresses defined in pool1. If the address of the packet passed to NAT is in

the range defined in the access control rule but is not one of the ones in the public address pool, NAT passes the packet back to IP unchanged.

7. If you wish the router to pass the packets that do not match the access control rule, rather than drop them, you can create a wildcard access control rule. The following example shows such an access control rule:

```
Packet-filter 'in-0' Config> add access
Enter type [E]? I
Internet source [0.0.0.0]? 0.0.0.0
Source mask [255.255.255.255]? 0.0.0.0
Internet destination [0.0.0.0]? 0.0.0.0
Destination mask [255.255.255.255]?0.0.0.0
Enter starting protocol number ([0] for all protocols) [0]?
Enable logging? (Yes or [No]):
Packet-filter 'in-0' Config>
```

8. Add an access control rule for NAT to the outbound packet filter. Packets to be forwarded from the net 0 interface that have a source address on the private network are identified so that IP can pass them to NAT. NAT replaces the private address with one of the public addresses in pool1.

```
Packet-filter 'out-0' Config> add access
Enter type [E]? IN
Internet source [0.0.0.0]? 10.33.96.0
Source mask [255.255.255.255]? 255.255.255.0
Internet destination [0.0.0.0]?
Destination mask [255.255.255.255]?0.0.0.0
Enter starting protocol number ([0] for all protocols) [0]?
Enable logging? (Yes or [No]):
Packet-filter 'out-0' Config>
```

   With this packet filter as with filter *in-0*, you can add a wildcard inclusive access control rule as the last access control rule if you plan to forward packets that do not match the access control rule.

9. You can use the **list packet-filter** *filter-name* command from the `IP Config>` prompt to check the accuracy and sequence of the access control rules in each packet filter.

10. Enable the access controls for IP.

```
IP Config> set access-control on
```

11. Reset IP and NAT using talk 5. Until now, you have created changes in the router configuration, but these changes have not affected the router. The reset commands for IP and NAT cause the router to read in the new configuration and run with the rules defined in the configuration.

```
NAT> reset NAT
IP> reset IP
```

Chapter 20. Configuring and Monitoring Network Address Translation

This chapter describes the Network Address Translation (NAT) configuring and monitoring commands and includes the following sections:

Accessing the Network Address Translation Configuration Environment

To access the NAT configuration environment, enter the following command at the `Config>` prompt:

```
Config> feature nat
Network Address Protocol user configuration
NAT config>
```

Network Address Translation Configuration Commands

This section explains the Network Address Translation (NAT) configuration commands. To configure NAT, enter these commands at the `NAT config>` prompt.

Table 37. NAT 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 xxvi.
Change	Changes public IP address reserve pools, private address translate ranges, and static mappings.
Delete	Deletes public IP address reserve pools, private address translate ranges, and static mappings.
Disable	Disables NAT.
Enable	Enables NAT.
List	Lists information about the NAT configuration.
Map	Creates a static NAT or NAPT binding for a station or server.
Reserve	Creates a public IP address pool and appends addresses to that pool.
Reset	Causes the router to read in the NAT configuration and run according to the NAT rules that have been configured.
Set	Sets timeouts.
Translate	Identifies the private IP addresses to be translated by the NAT public address pool.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Change

Use the **change** command to change public IP address reserve pools, private IP address translate ranges, and static mappings.

Syntax:

change reserve
translate
mappings

reserve *pools*
Provides prompts that enable you to change characteristics of any of the public IP address reserve pools (such as IP addresses and masks) .

Valid Values: An index number to identify the configured pool. This number is displayed when you enter the **list reserve pools** command.

Default Value: none

translate *ranges*
Provides prompts that enable you to change characteristics of any of the private IP address translate ranges (such as IP addresses and masks).

Valid Values: An index number to identify the configured translate range. This number is displayed when you enter the **list translate** command.

Default Value: none

mappings
Provides prompts that enable you to change characteristics of any of the static address mappings (such as IP addresses and ports).

Valid Values: An index number to identify the configured mapping. This number is displayed when you enter the **list mappings** command.

Default Value: none

Delete

Use the **delete** command to delete public IP address reserve pools, private IP address translate ranges, and mappings.

Syntax:

delete reserve
translate
mappings

reserve *pools*
Provides prompts that enable you to delete any of the public IP address reserve pools.

Valid Values: An index number to identify the configured pool. This number is displayed when you enter the **list reserve pools** command.

Default Value: none

translate *ranges*
Provides prompts that enable you to delete any of the private IP address translate ranges.

Valid Values: An index number to identify the configured translate range. This number is displayed when you enter the **list translate** command.

Default Value: none

mappings
Provides prompts that enable you to delete any of the static address mappings.

Valid Values: An index number to identify the configured mapping. This number is displayed when you enter the **list mappings** command.

Default Value: none

Disable

Use the **disable** command to disable NAT. You can disable NAT so that it will drop packets requiring translation or you can disable NAT so that it will pass packets requiring translation.

Syntax:

disable nat

drop

pass

drop Disables NAT so that it drops packets requiring translation.

pass Disables NAT so that it passes packets requiring translation.

Enable

Use the **enable** command to enable NAT. Enabling NAT makes it ready to run, but it will not run until you use the **reset** command or restart the router.

Syntax:

enable nat

List

Use the **list** command to list the public IP address reserve pools, the private IP address translate ranges, the mappings, the global settings, or all the NAT information.

Syntax:

list

reserve

addresses

pools

translate

mappings

global

all

In the following example, times are displayed as hours, minutes, and seconds. Entry age is the time elapsed since the entry was last used. A binding means that traffic is flowing between these two addresses. The timeouts determine how much time will elapse after the last communication before a binding is dropped. See the **set** command for more information about timeouts.

Example:

```
NAT config>list all
NAT Globals:
NAT is ENABLED
Tcp Timeout....:   24:00:00
Non-Tcp Timeout:    0:01:00
NAT Reserved Address Pool(s):
Index First Address    Mask             Count NAPT Address     Pool Name
1     9.8.7.1          255.255.255.0    3     0.0.0.0          pool1
2     9.8.7.6          255.255.255.0    12    9.8.7.9          pool1
NAT Translate Range(s):
Index IP Address       IP Mask          Associated Pool Name
1     7.1.1.0          255.255.255.0    pool1
2     10.0.0.0         255.0.0.0        pool1
NAT Static Mapping(s):
Index Private Address:Port    Public Address.:Port
1     10.1.2.3        0       9.8.7.1        0
2     7.1.1.1         21      9.8.7.9        21
```

Map

Use the **map** command to statically bind a host or server in the private network to a public address. This command, which can be used to set up servers in the private network, establishes an association at NAT startup that never changes.

Static mappings with the public and private port number 0 are NAT mappings; those with other values for the port numbers are NAPT mappings.

Syntax:

map *private-address private-port-number public-address public-port-number*

private-address

The private address of the workstation.

Valid Values: an Internet host address in valid IP format. This should be the address assigned to a station in the stub network that requires permanent access from the public network, such as a server.

Default Value: none

private-port-number

The TCP/UDP port number of the application running in the device with the private address. Entering **0** creates a NAT binding and entering another value creates a NAPT binding. Common port values for NAPT are 23 for Telnet, 21 for FTP, and 80 for HTTP.

Valid Values: 0 - 65535

Default Value: 0

public-address

The public IP address to which this private address is to be mapped. This must be a NAPT address for a NAPT mapping and a NAT address for a NAT mapping.

Valid Values: a valid IP address unique to the public network. The public network can be the Internet or an intranet, depending upon the design of the network.

Default Value: none

public-port-number
The port number of the packets to be translated at the public address. The value 0 represents all ports. Common values are 23 for Telnet, 21 for FTP, and 80 for HTTP.

Valid Values: 0 - 65535

Default Value: 0

In this example, the server with private IP address 10.11.12.200 accepts all traffic from the Internet; the server with private address 10.11.12.199 is a Telnet server and an FTP server.

Example:

```
map 10.11.12.200 0 9.8.7.2 0
map 10.11.12.199 23 9.8.7.9 23
map 10.11.12.199 21 9.8.7.9 21
```

Reserve

Use the **reserve** command to create and append a range of IP addresses to a public address pool.

Syntax:

reserve *public-address mask number-in-group name napt-address*

public-address
The first public IP address in the sequence of addresses that make up this range or group in the pool. For example, if this group in the pool includes the 12 addresses in sequence from 9.8.7.6 through 9.8.7.17, this value is 9.8.7.6.

Note: To add another range of addresses to the public address pool, use the **reserve** command separately for each group, relating one group to another by using the same pool name. For example, addresses 9.8.7.6 through 9.8.7.17 can be configured in one group within pool1 and addresses 9.8.7.1 through 9.8.7.3 can be configured in another group within the same pool. Then, addresses 9.8.7.4 and 9.8.7.5 are not configured or used by that pool.

Valid Values: a valid IP address that is unique to the public network

Default Value: none

mask A mask to select bits from the IP address. The mask, like an Internet address, is 32 bits long. The 1s in the mask select the network or subnet part of the address. The 0s select the host portion. For example, the address 9.8.7.6 and the mask 255.255.0.0 includes the range of all addresses of which the first two bytes are 9.8 (that is, 9.8.0.0 through 9.8.255.255).

Valid Values: any valid IP mask

Default Value: none

number-in-group
Specifies how many sequential addresses, beginning with the *public-address*, are included in the group. For the addresses 9.8.7.6 through 9.8.7.17, this value is 12.

Valid Values: 1 - the value that can be defined by the IP mask

Default Value: none

name The name of the public address reserve pool. This string has to match the pool name on the corresponding **translate** command.

Valid Values: any name, using up to 16 printable characters; leading and trailing blanks are ignored.

Default Value: none

napt-address
The one IP address from the public address pool that will be used by Network Address Port Translation (NAPT). This address is used for TCP and UDP traffic to map multiple private addresses to the one NAPT address according to the protocol port number. Using NAPT is optional. If it is used, there can be only one NAPT address per public address pool. If there is no NAPT address for a pool or group, enter the value **0.0.0.0**. You need only enter the NAPT address once for the pool.

Valid Values: one of the public IP addresses. It does not necessarily have to be included in the range of values defined in the public address pool, but it must be in the same subnet.

Default Value: 0.0.0.0 (meaning no NAPT)

Example:

```
reserve 9.8.7.1 255.255.255.0 3  pool1 0.0.0.0
reserve 9.8.7.6 255.255.255.0 12 pool1 9.8.7.9
```

Reset

Use the **reset** command to reset NAT. This command deletes all bindings, frees all memory used by NAT, and restarts NAT based on the current Talk 6 configuration. Resetting NAT does not disrupt any other components of the 2212.

Syntax:

reset nat

Note that if NAT encounters an invalid configuration, you will see a message to that effect. Review the NAT ELS messages to see why NAT initialization failed.

Set

Use the **set** command to set TCP and non-TCP timeouts.

Syntax:

set **tcp**

nontcp

tcp *timeout*
The time that NAT maintains a TCP binding after the last message passes between the two bound workstations. A binding is the maintenance of the relationship between a private address and one of the public IP addresses.

Valid Values: 0 - 65535 minutes (0 minutes to about 45 days)

Default Value: 1440 minutes (24 hours)

nontcp *timeout*
The time that NAT maintains a binding that is not TCP after the last message passes between the two bound stations. A binding is the maintenance of the relationship between a private address and one of the public IP addresses.

Valid Values: 0 - 65535 minutes (0 minutes to about 45 days)

Default Value: 1 minute

Translate

Use the **translate** command to add a subnet to the list of addresses that NAT will translate. Each subnet is a translate range. This command must be entered once for each translate range that NAT must know. Any number of translate ranges can use a single public address reserve pool.

Syntax:

translate *private-address mask name*

private-address
Any IP host or subnet address that should be translated.

Valid Values: an address in valid dotted decimal IP format. When ANDed with its subnet mask, this address identifies all addresses in a stub subnet. A stub subnet is a network that accesses the public network only through the router.

Default Value: none

mask **Valid Values**: The network or subnet mask associated with the stub network to be translated.

Default Value: class mask of the private address

name The name of the public address pool NAT should use for this range of private addresses.

Valid Values: any name, using up to 16 printable characters. It must match a public address pool name created by the **reserve** command.

Default Value: none

Accessing the Network Address Translation Monitoring Environment

To access the NAT monitoring environment, type

```
* t 5
```

Then, enter the following command at the **+** prompt:

```
+ feature NAT
NAT>
```

The NAT> prompt appears.

Network Address Translation Monitoring Commands

This section describes the IP Security monitoring commands. Enter these commands at the NAT> prompt.

Table 38. NAT 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 xxvi.
List	Lists information about NAT.
Reset	Causes the router to read in the NAT configuration and run according to the NAT access rules that have been configured. NAT does not affect the running of the router until you enter the **reset NAT** command.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

List

Use the **list** command to display information about the NAT configuration.

Syntax:

list
- all
- binding
- fragment
- global
- reserve
  - pools
  - addresses
- statistics
- translate

In the following example, times are displayed as hours, minutes, and seconds. Entry age is the time elapsed since the entry was last used. A binding means that a session is established between these two addresses. The timeouts determine how much time will elapse after the last communication before a binding is dropped. See the **set** command in Talk 6 for more information about timeouts.

Example:

```
NAT>list all
NAT Globals:
Current State    Tcp Timeout    Non-Tcp Timeout    Memory Usage (in bytes)
ENABLED            24:00:00            0:01:00           408

NAT Statistics:
Requests :     Passes      Drops      Holds
       0 :          0          0          0

NAT Address Binding(s):
Private Address//Port  Public Address//Port  Bind Type  Entry Age
        7.1.1.1    21         9.1.1.1    21  STATIC       0:00:13
       10.1.2.3     0         9.1.1.2     0  STATIC       0:00:13
```

```
NAT TCP Session Information:
Private Address//Port  Public Address//Port  Tcp State  Data Delta  Entry Age
        7.1.1.1    21         9.1.1.1    21  ESTAB'ED      0        0:00:56

NAT Translate Range(s):
Base Ip Address        Range Mask      Associated Reserve Pool
       7.1.1.0         255.255.255.0   carol
      10.0.0.0         255.0.0.0       carol

NAT Reserve Pool(s):
Reserve Pool     Pool Size    NAPT Address   1st Available Address
carol                21            9.1.1.1          9.1.1.12
------------------------------------------------------------
Number of Reserve Pools using NAPT.....:     1
Number of configured Reserved Addresses:    21

NAT Fragment Information:
Number of Entries    Number of Saved Fragments
           0                          0
```

Reset

Use the **reset** command to reset NAT. This command deletes all bindings, frees all memory used by NAT, and restarts NAT based on the current Talk 6 configuration. Resetting NAT does not disrupt any other components of the 2212.

Syntax:

reset nat

Chapter 21. Using a Dial-In Access to LANs (DIALs) Server

A DIALs Server allows remote users to dial in to a LAN and access the resources of the LAN in the same manner as if they were locally attached with a LAN adapter. Similarly, the DIALs Server also allows LAN-attached users to dial out to WAN resources (such as bulletin boards, FAX machines, Internet Service Providers (ISP) and other on-line services) eliminating the need for an analog phone line and modem on their workstation.

The DIALs Server can be configured for both dial-in and dial-out users simultaneously. The IBM DIALs Dial-In Client runs on the remote workstation and provides the dial-in function. Figure 20 shows an example of a device used as a DIALs Server supporting the dial-in function.

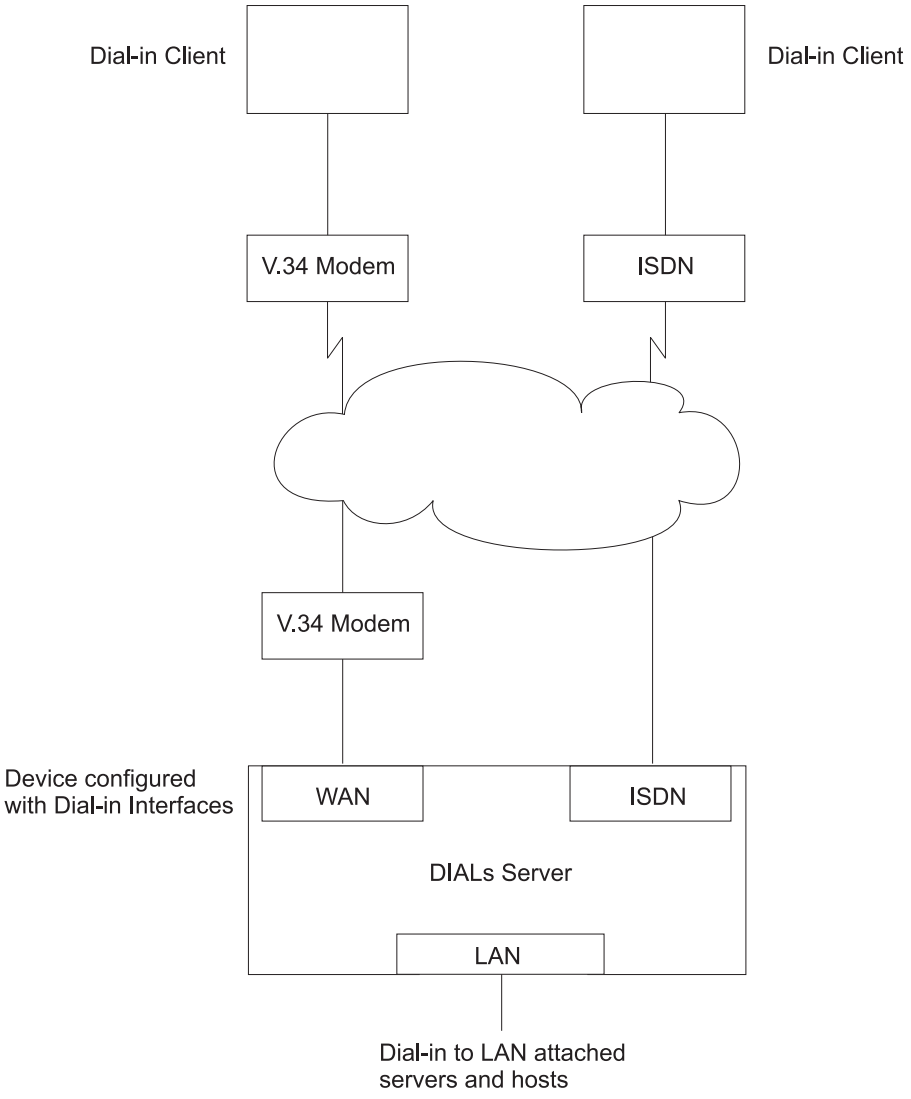


Figure 20. An Example of a DIALs Server Supporting Dial-In

The IBM DIALs Dial-Out Client runs on the network-attached workstation and provides the dial-out function. Figure 21 on page 238 shows an example of a 2212 used as a DIALs Server supporting the dial-out function.

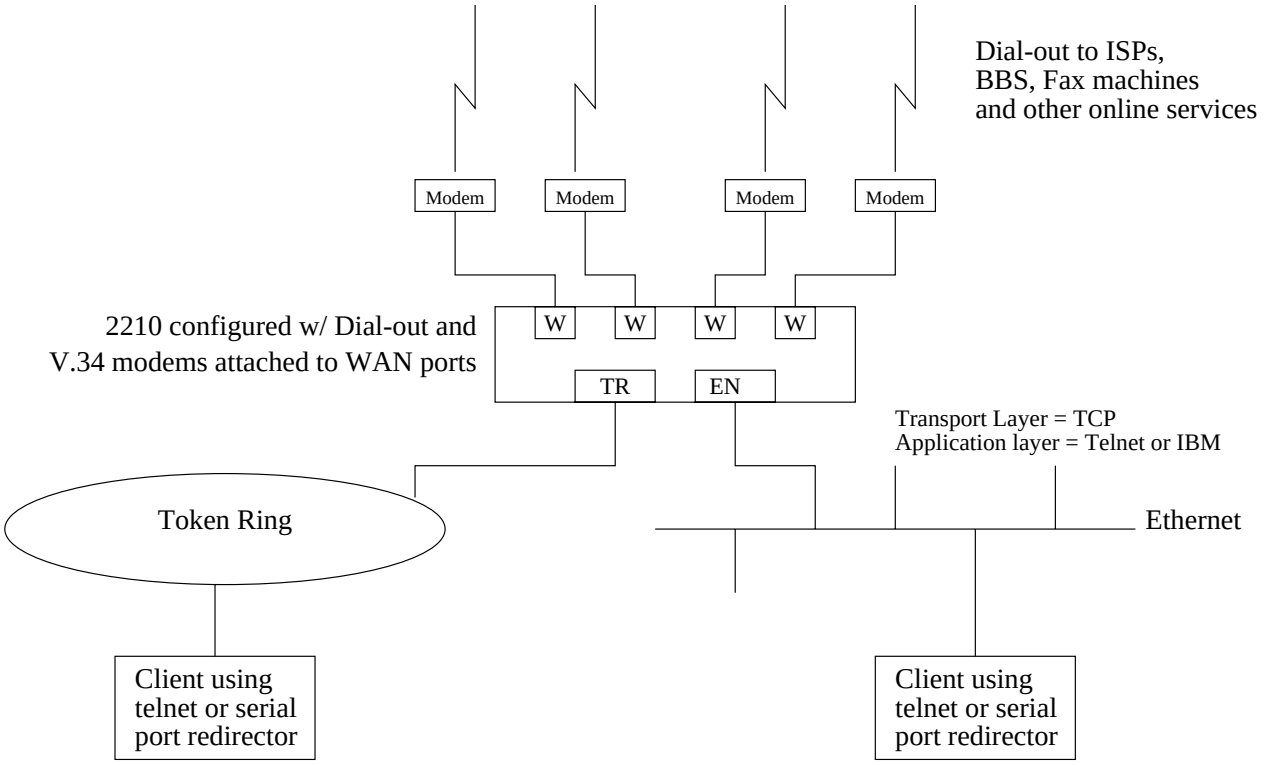


Figure 21. An Example of a DIALs Server Supporting Dial-Out

Before Using Dial-In-Access

Before using Dial-In Access, you need:

- A workstation running the IBM DIALs Dial-In Client or another PPP dial-in client (referred to as the ***dial-in client*** or ***PPP dial-in client*** throughout the following sections).
- Completed protocol configurations on the client machine.
- ISDN interfaces or integrated modem interfaces or external V.34 modems connected to the WAN ports of the 2212 that you want to use for single user dial-in.
- A fully configured DIALs Server in your LAN.

Configuring Dial-In Access

This section describes how to configure both dial-in and dial-out functions on the DIALs Server. Configuring a client to use dial-in access is described in the documentation associated with the client the workstation uses.

Configuring Dial-In Interfaces

Dial-in interfaces on the 2212 are a special type of dial-circuit. Because most of the settings for a typical dial-circuit are not relevant for single-user dial-in applications, a new device type called ***dial-in*** can be added that sets appropriate defaults for the dial-circuit. Adding a dial-in device also sets up the PPP encapsulator configuration defaults that work with the majority of PPP dial-in clients, including the IBM DIALs

Dial-In client. These defaults are described in “Dial Circuit Parameter Defaults for Dial-In Interfaces” and “Dial Circuit PPP Encapsulator Parameters for Dial-In Circuits”.

Note: DIALs function can only be enabled on dial-in circuits. Dial-in circuits are only supported when the base net is a V.34 net.

Dial Circuit Parameter Defaults for Dial-In Interfaces

Notes:

1. Do not override the parameters described in this section. Doing so will prevent the dial-in function from operating correctly.
2. Some parameters may not be displayed or configurable. For a complete description of the parameters, see “Configuring and Monitoring Dial Circuits” in the *Access Integration Services Software User’s Guide*.

The following defaults are set when you add a dial-in interface:

- ***Idle time*** is set to 0. Note that a standard circuit is defined as a circuit where the idle timer has no meaning. It will not be a fixed circuit to automatically dial-out. The only time the circuit will dial-out is if a PPP callback has been negotiated or if Multilink PPP has been enabled on this circuit. See “Shiva Password Authentication Protocol (SPAP)” and “Using the Multilink PPP Protocol” in the *Access Integration Services Software User’s Guide* .
- ***Inbound calls*** are allowed. Any inbound is setup because PPP dial-in clients do not use the LID exchange implemented by Nways dial-circuits.
- ***Outbound calls*** are allowed.

  Note: “Outbound” for a dial-in circuit is not the same as a dial-out circuit. See “Before Configuring Dial-Out Interfaces” on page 240.

- A default destination address is set up for “default_address” This address is added to the list of V.34 addresses. Because these calls are inbound and the only outbound calls will be the result of either a callback or a multilink PPP exchange, the destination address is meaningless. However the address is required for the circuit parameters. Do not delete this address or your circuits will come up disabled.

Dial Circuit PPP Encapsulator Parameters for Dial-In Circuits

Note: For a complete description of the following parameters see “Using Point-to-Point Protocol Interfaces” in *Access Integration Services Software User’s Guide*.

The following defaults are set when you add a dial-in interface:

- Authentication is enabled for SPAP, CHAP, and PAP.
- The PPP MRU is set to 1522. This MRU size is needed for the Windows 3.1, OS/2, and DOS versions of the IBM DIALs Dial-In clients. Do not change this setting unless you know you are not using these clients.
- Automatically enables DIALs on the PPP encapsulator. This turns on some of the features important for Dial-In Access to LANs users such as the NetBIOS Control protocol, NetBIOS Frame Control protocol, time remaining, SPAP authentication, callback, LCP identification, and automatic addition and deletion of IP static routes to the client. See “Using Point-to-Point Protocol Interfaces” in *Access Integration Services Software User’s Guide* for more information on the DIALs features.

Adding a Dial-In Interface

To add a dial-in interface:

1. Configure a V.34 base net on one of the available WAN interfaces of the 2212. See “Using the V.34 Network Interface” in the *Access Integration Services Software User’s Guide* for configuration details.
2. Enter **talk 6** to access the `Config >` prompt.
3. Enter **add device dial-in** at the `Config >` prompt to add the dial-in interface. You will be asked how many dial-in circuits to add. This command will create the new nets, report their net numbers, prompt for the base net number and prompt to enable for Multilink PPP.

   Example: Assume the current maximum net is 3 and you want to add 1 dial-in net to the base 2 net.

Figure 22 is an example of defining a dial-in interface.

Figure 22. Adding a Dial-In Interface

```
Config>add dev dial-in
Adding device as interface 4
Defaulting Data-link protocol to PPP
Use "net 4" command to configure circuit parameters
Base net for this circuit [0]? 2

Enable as a Multilink PPP link? [no]

Disabled as a Multilink PPP link.

Use "set data-link" command to change the data-link  protocol
Use "net " command to configure dial circuit parameters.
Config>li dev
Ifc 0     Ethernet               CSR  81600, CSR2  80C00, vector 94
Ifc 1     V.34 Base Net          CSR  81620, CSR2  80D00, vector 93
Ifc 2     V.34 Base Net          CSR  81640, CSR2  80E00, vector 92
Ifc 3     PPP Dial-in Circuit
Ifc 4     PPP Dial-in Circuit
```

Before Configuring Dial-Out Interfaces

Before configuring and using dial-out interfaces on the 2212, you need:

- IBM software with DIALs support loaded on a 2212.
- An external V.34 modem, or an integrated modem if connecting to an available WAN port on the 2212. See “Using the V.34 Network Interface” in the *Access Integration Services Software User’s Guide* for configuration information.
- A workstation connected to the LAN that has access to the 2212 DIALs Server.
- Software on the client such as telnet, a telnet redirector or the IBM DIALs Dial-Out clients. IP must be correctly configured on the client in order for the dial-out client to work.

Configuring Dial-Out Interfaces

The following steps describe how to configure a dial-out interface on your device.

1. Connect a V.34 modem to the WAN port that you will use as a dial-out interface.
2. Connect to the console of the 2212 DIALs Server.
3. Enter **talk 6** at the * prompt.
4. Set up a V.34 interface. See “Using the V.34 Network Interface” in the *Access Integration Services Software User’s Guide* for details.

5. Add a dial-out interface using the **add device dial-out** command. When prompted for the interface, use an available V.34 interface number.

   Notes:

   a. Multiple circuits can be configured on top of a V.34 base net. However, only one circuit can be active at any given time.

   b. The software defines a V.34 address called ***default_address***. Do not delete this address as it is required by dial-out and dial-out will not work without it.

6. Configure the PPP authentication server, if you are using the IBM DIALs Dial-Out client, and add PPP users as described in "PPP Authentication Protocols" in the *Access Integration Services Software User's Guide*. The added PPP users should have dial-out enabled. Dialing out using telnet does not require authentication, therefore do not configure authentication for telnet sessions.
7. Configure the global dial-out parameters using the **feature dials** command. See the **feature** command in the *Access Integration Services Software User's Guide*.

   In this environment you can configure the dial-out inactivity timer, the dial-out server name, modem pools, and other parameters.
8. For the IBM DIALs Dial-Out client to work correctly, a SNMP community must be defined with read access granted to all dial-out clients that should be able to use the dial-out server. This is required for the dial-out chooser application to be able to discover dial-out servers on the network. Refer to "SNMP Management" in the *Protocol Configuration and Monitoring Reference Volume 1* for information about how to configure a SNMP community.
9. Restart the device.

Configuring Modem Pools

Modem pools are defined as a group of modems which appear to the user as one modem. When the user needs to dial-out, the first available modem in this pool is used. Modem pools are created in the 2212 DIALs Server by defining groups of dial-out interfaces with the same portname. By default, all dial-out interfaces are named "ALL_PORTS" which creates a modem pool. Naming the dial-out interfaces individually enables a user to select a particular modem to dial-out.

To configure a modem pool:

1. Enter **talk 6** at the * prompt.
2. Enter **net *n***, where ***n*** is the number of the dial-out interface as defined in "Using the V.34 Network Interface" in the *Access Integration Services Software User's Guide*. This action places you in the configuration environment for the interface.
3. Enter **encapsulator** (see "Configuring and Monitoring Dial Circuits" in the *Access Integration Services Software User's Guide*) at the `Circuit Config>` prompt. This action places you in the dial-out configuration environment.
4. Enter **set portname** at the `Dial-out Config>` prompt. This action will prompt you for the name of the port (up to 30 characters). If you specify an existing port name, the modem is added to the pool with that name.
5. Restart the 2212.

Before Configuring Global DIALs Parameters

This section describes the global DIALs Server parameters.

Server Provided IP Addresses

The router can be configured to provide an IP address for a dial-in client to use for the duration of its connection. The address the router will assign to the client can be retrieved by 4 different methods. These methods, in order of priority are listed below:

1. User ID

   An IP address can be stored in the PPP user profile for each client. When a client connects and requests an IP address, the router retrieves the address configured in that user's PPP user profile. This allows the user to get the same IP address each time, but requires a unique IP address for every user.

   Use the `Config>` **add ppp-user** command to configure an IP address in the PPP user profile.

2. Interface

   An IP address can be stored in the dial-in interface configuration. When a client connects and request an IP address, the router retrieves the address from the interface through which the connection was made. This method requires a unique IP address for each dial-in interface.

   To set the interface IP address:

   - Use the `Config>` **list devices** command to display the interface number assigned to the hardware interface.
   - Use the `Config>` **net 'x'** command, where 'x' is the configured interface number, to access the command prompt for the interface.
   - Use the `PPP Config>` **set ipcp** command to set the interface IP address.

3. Pool

   Blocks of IP addresses can be stored in a IP address pool. When a client connects and requests an address, the router retrieves an address from the pool. When the client disconnects, the address is returned to the pool. This method provides a single location for configuring dial-in client's IP address without the need for an address server.

   Use the `DIALs config>` **add ip-pool** command to add a pool of IP addresses.

4. DHCP Proxy

   An IP address can be leased from a DHCP server. When a client connects and requests an address, the router request an address from the DHCP server on behalf of the client. This method requires a DHCP server be present on the LAN. One DHCP server can provide addresses for clients on multiple routers. See "Dynamic Host Configuration Protocol (DHCP)" on page 243for more information.

   Use the `DIALs config>` **add dhcp-server** command to add a DHCP server.

IP Address Assignment Methods

The IP address used by a dial-in client for the duration of the connection may come from 5 different sources. These sources are listed in order of precedence:

1. client provided
2. user id assigned
3. interface assigned
4. address pool
5. DHCP server

When a dial-in client connects, the router steps through these sources until it finds an address or exhausts all sources. If no IP address can be found, IPCP negotiation fails. Any combination of methods may be used.

The default configuration is:

```
Client     :  Enabled
UserID     :  Enabled
Interface  :  Enabled
Pool       :  Enabled
DHCP Proxy :  Disabled
```

Note: There are no addresses configured by default in the PPP user profile, the interface or the IP address pool.

Dynamic Host Configuration Protocol (DHCP)

The Dynamic Host Configuration Protocol (DHCP) was developed to provide configuration parameters to hosts on a network. Among other configuration parameters, DHCP has a mechanism for allocation of network addresses to hosts.

The Proxy DHCP feature acts as a client *on behalf* of a dial-in PPP user. This allows the device to obtain an IP address lease for the duration of the dial-in session, or until the lease expires. The IP address that is allocated from the DHCP server is communicated to the dial-in client through PPP IPCP (see “IP Control Protocol” in the *Access Integration Services Software User’s Guide* for a description of IPCP). The dial-in client software has no knowledge that DHCP was used to allocate an IP address, and thus requires no DHCP activation of any kind.

Proxy DHCP requires that at least one DHCP server be configured and accessible from the router.

Proxy DHCP requires that the addresses being allocated to dial-in users be within the same subnet of a directly connected LAN. In a typical configuration, this requires enabling proxy ARP subnet routing to allow the router to answer ARP requests to hosts on the local network on behalf of the dial-in clients.

Basic DHCP Setup

The most basic configuration calls for a single DHCP server on the same network as the router, with dial-in addresses to be leased within the same subnet as this LAN.

When the client dials in, a lease for an IP address is obtained from the DHCP server and used in IPCP negotiation with the client.

1. Connect 2212 and DHCP to the same LAN.
2. Configure and start the DHCP server (see your DHCP server’s documentation for how to setup your server to lease IP addresses. Remember, the IP addresses to be leased MUST be within a subnet of a directly connected LAN and proxy ARP must be enabled on the 2212).
3. The typical setup for Proxy DHCP disables Client-Specified, Userid, and Interface and Pool IP Address Negotiation options:

```
Dials Config>list ip
DIALs client IP address specification:
Client : disabled
UserID : disabled
Interface : disabled
DHCP Proxy : enabled
```

4. Add DHCP server (`Dials Config>` **add dhcp 10.0.0.111**)
5. Set dial-in client software to *Server assigned*.

   Notes:

   a. *Server assigned* configuration varies among different dial-in client implementations.

   b. The client software should not be configured to obtain its address from DHCP. The client should obtain its address by sending an address of 0.0.0.0 to IPCP on the initial configure request.
6. For this setup, let the DHCP GATEWAY ADDRESS default to 0.0.0.0.

Multiple Hops to DHCP Server

The configured DHCP server(s) should be IP addresses which are reachable from the connected router. You should always be able to ping the server from the remote access box.

When the DHCP server is located multiple hops away, the server needs to know an address to reply to, and to indicate which pool to allocate an IP address from. The pool to allocate an IP from is important because the DHCP server could be utilized to serve addresses to a number of subnets and there must be some indication as to which pool of addresses to select from. The DHCP Gateway Address (*giaddr*) is used for this (the terminology is based on the definition given in RFC 2131). The *giaddr* must be an address that is local to the 2212, such as the token ring or Ethernet LAN port. Also, since the *giaddr* is the address which the DHCP server will use to reply, make sure you can ping this address from the DHCP server itself.

Multiple DHCP Servers Network

You can configure multiple DHCP servers for redundancy. When you configure multiple servers, the Proxy DHCP client asks all servers for an address and accepts the first response received. If any of the DHCP servers are more than one hop away, or are connected to a subnet which is not associated with the addresses in its pool, then *giaddr* must be configured. See “Multiple Hops to DHCP Server”.

While there can be more than one DHCP server offering addresses, it is important to not allow the pool of addresses configured at each server to overlap. Further, because there is only one *giaddr* for the DHCP server to respond to and perform a lookup with, each pool of address must be in the same subnet as each other.

Dynamic Domain Name Server (DDNS)

A Domain Name Server (DNS) maps IP addresses to hostnames and is typically static in nature. Dynamic DNS is a feature that, when used with a DDNS DHCP server and a DNS server, enables DHCP to dynamically update the DNS server with an IP address and hostname mapping. This feature may only be used in conjunction with Proxy DHCP.

When you enable Dynamic DNS on the 2212 and you configure a hostname in the user profile (see “PPP Authentication Protocols” in the *Access Integration Services Software User’s Guide*), this hostname is passed as option 81 (DDNS) to the DHCP SERVER. If you configured the DHCP server correctly for DDNS, the DHCP server updates the DDNS server with the IP address that it leased to the router and the

hostname that the router sent to it. This allows other users to access the dial-in client through the hostname rather than requiring the client to know the dynamically chosen IP address.

Chapter 22. Configuring DIALs

This chapter describes DIALs configuration and operational commands. The chapter includes:

Accessing the DIALs Global Configuration Environment

Use the following procedure to access the global configuration process.

1. At the OPCON prompt, enter **talk 6**. (For more detail on this command, refer to *The OPCON Process and Commands* in the Access Integration Services Software User's Guide.) 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 **Return** again.
2. At the CONFIG prompt, enter the **feature dials** command to get to the `DIALs Config>` prompt and access the DIALs global parameter configuration environment.

DIALs Global Configuration Commands

Table 39. DIALs Global 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 xxvi.
Add	Adds a (Dynamic Host Configuration Protocol) DHCP server to the list of DHCP servers or adds an IP address pool.
Delete	Deletes a DHCP server from the list or removes a block of addresses from an IP address pool
Disable	Disables IP address assignment methods, dial-out protocols, multi-chassis MP, SPAP Banner, and Dynamic DNS.
Enable	Enables various methods of IP address assignments, dial-out protocols, multi-chassis MP, SPAP Banner, and Dynamic DNS.
List	Lists the Global DIALs parameters and their values.
Set	Sets time-allowed, dhcp gateway address, NetBIOS Name Server addresses, locally assigned MAC addresses, Virtual Connections (VC) Dynamic Name Server addresses, dial-out inactivity timer, and dial-out server-name.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Add

Use the **add** command to add a new Proxy DHCP server to a list of servers or to add an IP pool of addresses.

The proxy DHCP server list contains the IP addresses of the DHCP servers that will, in turn, lease IP addresses to the dial-in clients. Multiple servers may be added for redundancy. The maximum number of servers is 20.

The IP address pool feature provides a method by which the router may retrieve an IP address from a locally defined pool of addresses to a dial-in client. The client may use this address for the duration of the connection to the router. A pool consists of one or more blocks of IP addresses. The maximum number of blocks is 20. Each of these blocks is defined by a base IP address and the number of addresses in the block. The addresses in each block are ascending and contiguous, starting with the base address.

Syntax:

add dhcp-server *ipaddress*

ip-pool *baseaddress #addresses*

dhcp-server *ipaddress*

Adds a dhcp-server with the specified IP address.

Example :

```
DIALs Config> add dhcp-server
DIALs Proxy DHCP server address [0.0.0.0]? 10.0.0.1
```

ip-pool *baseaddress #addresses*

Add a block of addresses to the IP pool.

Example:

```
DIALs Config> add ip-pool
Base address []? 192.1.100.18
Number of addresses [1]? 57
DIALs config>add ip-pool
Base address []? 192.2.200.1
Number of addresses [1]? 250
DIALs config>list ip-pools
     Configured IP address pools:
          Base Address      Last Address        Number
          ------------      ------------        ------
          192.1.100.18      192.1.100.74            57
           192.2.200.1     192.2.200.250           250
```

Delete

Use the **delete** command to delete an existing Proxy DHCP server from the list of servers or to remove a block of addresses from the IP address pool.

Syntax:

delete dhcp-server *ip address*

ip-pool *baseaddress #addresses*

dhcp-server *ipaddress*

Removes a dhcp-server with the specified IP address.

Example:

```
DIALs Config> delete dhcp-server
Enter the address to be deleted [0.0.0.0]? 10.0.0.1
```

ip-pool *baseaddress #addresses*
Removes a block of addresses from the IP pool.

Example:

```
DIALs Config> delete ip-pool
Base IP address of the block to be removed []? 192.2.200.1
```

Disable

Use the **disable** command to disable an IP address assignment method, dial-out protocols, SPAP Banner, and Dynamic DNS.

Syntax:

disable dynamic-dns
dial-out
ip-address-assignment *type*
spap-banner

dial-out ***type***
Disables the use of dial-out with either telnet or IBM DIALs Dial-Out clients. You can specify:

dials Disables all IBM DIALs Dial-Out clients

telnet Disables all telnet clients.

To disable both types of clients you must enter the disable dial-out command for each type. Disabling both types of clients disables dial-out on the 2212.

dynamic-dns
Disables the sending of DHCP option 81 for the user's hostname. See "Dynamic Domain Name Server (DDNS)" on page 244 for more information.

IP-address-assignment ***type***
Disables various IPCP address assignment techniques. You may specify any of the following:

- Client – Prevents client-assigned IP address assignment.
- Userid – Prevents using the authenticated user profile for an IP address.
- Interface – Prevents the router from using the IPCP settings for the interface.
- Pool – Prevents the router from using the IP address pool to assign addresses to clients.
- DHCP-proxy – Prevents the router from leasing an address from the DHCP server.

See "Server Provided IP Addresses" on page 242 for additional information about assignment techniques.

spap-banner
Disables the sending of a SPAP banner to a remote user authenticated with SPAP.

Note: Entering a \n will force a new line character in the banner displayed at the client.

Enable

Use the **enable** command to enable IP address assignment, dial-out protocols, SPAP Banner, and Dynamic DNS.

Syntax:

enable dynamic-dns
ip-address-assignment . . .
spap-banner

dial-out *type*
Enables the use of dial-out with either telnet or IBM DIALs Dial-Out clients. By default, both types of clients are enabled. You can specify:

dials Enables all IBM DIALs Dial-Out clients

telnet Enables all telnet clients.

dynamic-dns
Disables sending of DHCP option 81 for the user's hostname. See "Dynamic Domain Name Server (DDNS)" on page 244 for more information.

IP-address-assignment *type*
Enables various IPCP address assignment techniques. The router will attempt each method enabled in the order listed. You may specify any of the following:

- Client – Allows the client to specify the address it wants to use.
- Userid – The router will look in the authenticated PPP user profile for an IP address. If the address is nonzero, it will be offered to the client.
- Interface – The router will look at the IP address configured on the interface. If the address is nonzero, it will be offered to the client.
- Pool – The router will request an address from the IP address pool. If an address is available, it will be offered to the client.
- DHCP-proxy – The router will attempt to lease an address from DHCP. If successful, the address will be offered to the client.

See "Server Provided IP Addresses" on page 242 for additional information about assignment techniques.

spap-banner
Enables the sending of a SPAP banner to a remote user authenticated with SPAP. Use the **set spap-banner** command described on "Set" on page 252 to enter the text of the SPAP banner. Refer to "Shiva Password Authentication Protocol (SPAP)" in the *Access Integration Services Software User's Guide* for more information.

List

Use the **list** command to display the current configuration. The DHCP state and lease times can be monitored for each net from the Point-to-Point console. See the **listipcp** command in the *Access Integration Services Software User's Guide* for an example.

Syntax:

list all

dhcp-servers

dial out

dynamic-dns

ip-address-assignment

ip-pools

name-servers

spap-banner

time-allowed

vc-parameters

Example:

```
DIALs config>li all
DIALs client IP address assignment:
Client     :  Enabled
UserID     :  Enabled
Interface  :  Enabled
Pool       :  Enabled
DHCP Proxy :  Disabled


Configured IP address pools:
     Base Address      Last Address        Number
     ------------      ------------        ------
       11.0.0.100        11.0.0.129            30
       11.0.0.210        11.0.0.229            20

Configured DHCP servers:           11.0.0.2         11.0.0.50
Proxy DHCP is currently disabled
DHCP gateway address (giaddr): 11.0.0.10

Dynamic DNS: Enabled

Primary Domain Name Server     (DNS): 11.0.0.2
Secondary Domain Name Server   (DNS): None
Primary NetBIOS Name Server   (NBNS): 11.0.0.2
Secondary NetBIOS Name Server (NBNS): None

Time allowed for connections: Unlimited

SPAP banner  :Enabled
Welcome to the network...

Box-level dial-out settings
Inactive timer:                                      15
LAN Protocols enabled for dial-out:         TELNET DIALs
Server name:                                          DIALOUT_SERVER

Number of Mac Addresses defined = 0
Base MAC Address: 000000000000

VC: Maximum Virtual Connections = 50
VC: Maximum suspend time (hours) (0 is unlimited) = 12
VC: Idle timeout period (seconds) = 30

Multi-chassis MP: Endpoint discriminator (0 means use box s/n) = 0

DIALs config>
```

The example shows the following:

DIALs client IP address specification

Displays the IP address assignment techniques and whether they are enabled. You would receive this section of the display and the section containing the box-level dial-out settings in response to the **list ip-address-assignment** command.

IP address pools
Displays the configured IP address pools. You would receive this section of the display in response to the **list ip-pool** command.

Configured DHCP servers
Displays the list of IP addresses currently configured as DHCP servers. This section also lists the interface being used for the DHCP gateway. You would receive this section of the display in response to the **list dhcp-servers** command.

Dynamic Name Servers
Displays whether Dynamic DNS is enabled. You would receive this section of the display in response to the **list dynamic-dns** command.

primary domain server (dns)
This line and the following lines display the configured primary and secondary name servers. You would receive this section of the display in response to the **list name-servers** command.

time allowed
Displays the maximum amount of time (in minutes) for dials users. You would receive this section of the display in response to the **list time-allowed** command.

spap banner
Displays the contents of the spap banner. You would receive this section of the display in response to the **list spap-banner** command.

vc connections
Displays information about configured virtual connections.

multi-chassis mp
Displays the configured endpoint discriminator.

Set

Use the **set** command to set the time-allowed, dhcp gateway address, NetBIOS Name Server addresses, Dynamic Name Server addresses and dial-out inactivity timer , and dial-out server-name.

Syntax:

set dhcp-gateway-address
dial-out . . .
dns . . .
laa
multi-chassis-mp
nbns . . .
spap-banner . . .
time-allowed
vc-parameters

dhcp-gateway-address *interface# ipaddress*
Sets the IP address associated with the DHCP gateway. DHCP uses the address as:

1. An address to which DHCP replies

2. An indication of the pool of addresses from which DHCP allocates an IP address

If the DHCP server is not on a directly attached LAN interface, then you must configure this address to the address of one of the LAN interfaces that has IP connectivity to the DHCP server. See “Dynamic Host Configuration Protocol (DHCP)” on page 243 and the definition of “giaddr” in RFC 1541 for more information.

dial-out ***parameter***

Sets the inactivity timer or server name for dial-out nets. ***Parameter*** can be:

inactivity-timer

Sets the dial-out inactivity timer for dial-out nets. This is defined as the amount of time, in minutes, that a user can be connected without data traffic over the connection. For example, if the inactivity-timer is set to 5 minutes and during any 5 minute interval, no data is received or transmitted, the connection will be dropped and the modem will become available. The default is 0, which means that the inactivity timer is disabled and the connection will be maintained indefinitely.

servername

Sets the name of the dial-out server. This can be any string up to 30 characters in length. The default is “2210_DIALS_SERVER”. This is the name that the IBM DIALs Dial-Out clients see when they use the “Chooser” application to discover dial-out servers. This parameter has no meaning for telnet dial-out clients.

dns ***type ipaddress***

Configures the primary and secondary domain name servers (DNS). ***Type*** can be:

primary

Sets the IP address of the primary DNS server for the dial-in client to use. This value is negotiated during IPCP for some dial-up clients (particularly Windows 95).

secondary

Sets the IP address of the secondary DNS server for the dial-in client to use. This value is negotiated during IPCP for some dial-up clients (particularly Windows 95).

laa *#MAC_addresses MAC_address_base*

Sets the number of MAC addresses and the base address for the Locally Administered Address (LAA) table. Only Layer-2-Tunneling nets will use LAA addresses.

#MAC_addresses

Specifies the number of Mac addresses to add to the LAA table, beginning with the *MAC_Address_Base*.

Valid values: 0 to 256

Default value: 0

MAC_address_base

Specifies the base MAC address of the LAA table.

Valid values: Any valid MAC address

Default value: 000000000000

Example:

```
DIALs config>set laa
    Number of Mac Addresses:  [0]? 20
    Locally Administered Mac Address Base (hex) [000000000000]? 002210aaaaaa
    DIALs Config>
```

multi-chassis-mp

Sets the endpoint discriminator to be used. All links that are to join the same bundle must have the same endpoint discriminator.

Example:

```
DIALs Config> set multi-chassis-mp
   Enter Endpoint Discriminator to use from stacked group (0 for box S/N): 2345
```

nbns *type ipaddress*

Configures the primary and secondary NetBIOS name servers. ***Type*** can be:

primary

Sets the IP address of the primary NetBIOS name server.

secondary

Sets the IP address of the secondary NetBIOS name server.

spap-banner

Allows configuration of a message that is sent out to all clients that successfully complete SPAP authentication.

Example:

```
DIALs config>set spap-banner
SPAP banner  :Disabled

Enter Banner: Welcome to the network...
```

time-allowed

Sets the time allowed for PPP dial-in users and dial-out users. This parameter defines the maximum amount of time (in minutes) that a user can be connected. The default value is 0, which means the user can be connected for an unlimited amount of time.

vc-parameters

Use this parameter to set the global default virtual connection attributes. The system prompts you for the maximum number of connections, the maximum suspend time, and the inactivity timeout value.

Example:

```
Config> feature DIALs
DIALs Config> set vc-parameters
Maximum Virtual Connections [50]? 40
Maximum suspended time (hours) (0 is unlimited) [10]? 18
Inactivity Timeout (seconds) [30]? 60
DIALs Config>
```

Maximum Virtual Connections

The maximum number of virtual connections that can be active or suspended. When using VCs with MP, configure this value to be 1 greater than the number of physical connections.

Valid values: 0 to 255

Default value: 50

Maximum suspended time

The maximum amount of time, in hours, a virtual connection can be

suspended before the system ends the connection. Specifying 0 for this parameter allows a virtual connection to be suspended indefinitely.

Valid values: 0 to 48

Default value: 12

Inactivity Timeout
The number of seconds that a virtual connection can be inactive before it is suspended.

Valid values: 10 to 1024

Default value: 30

Accessing the DIALs Global Monitoring Environment

Use the following procedure to access the DIALs monitoring commands.

1. At the OPCON prompt, enter **talk 5**. (For details on this command, see the chapter "The OPCON Process and Commands" in *Access Integration Services Software User's Guide*.) 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 **Return** again.

2. At the + prompt, enter the **feature dials** command to get you to the `DIALS Console>` prompt and access the global monitoring environment.

   Example:

```
+ feature dials
DIALS Console>
```

DIALs Global Monitoring Commands

Table 40. DIALs Global Monitoring Commands

Command	Function
Clear	Clears a specific suspended virtual connection.
List	Displays the state of various virtual connections, or all virtual connections.
Reset	Dynamically activates DIALS parameters.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Clear

Use the **clear** command to clear specific suspended virtual connections.

Syntax:

clear vc *connection_id*

vc *connection_id*
Specifies the suspended virtual connection that you are ending. To obtain the *connection_id*, enter either the **list all-vc** or **list suspended-vcs** command.

List

Use the **list** command to display all virtual connections, active virtual connections, suspended virtual connections, or the values of the vc-parameters.

Syntax:

list all
active-vcs
all-vcs
dhcp-servers
ip-address-assignment
ip-pool
suspended-vcs

active-vcs
Displays the attributes of all active virtual connections. See description of the **all-vcs** parameter for an explanation of the attributes.

all-vcs
Displays the attributes of all active and suspended virtual connections. This display is a combination of the displays for the **list active-vcs** and **list suspended-vcs** commands.

Example:

```
+ feature dials
DIALS console> list all
 DIALs client IP address assignment:
Client     :  Enabled
UserID     :  Enabled
Interface  :  Enabled
Pool       :  Enabled
DHCP Proxy :  Disabled


Current IP address pools:
     Base Address      Last Address         Total          Free
     ------------      ------------         -----          ----
*      11.0.0.100        11.0.0.129           30            30
       11.0.0.210        11.0.0.229           20            19

Current DHCP servers:           11.0.0.2         11.0.0.50
Proxy DHCP is currently disabled
DHCP gateway address (giaddr): 11.0.0.10


Active VCs:
Conn ID    Interface Idle-Timeout Connected Username
========== ========= ============ HHH:MM:SS ================
1656494850         8           30   0:26:15 don
7293521502         9           30   1:41:57 jane


Suspended VCs:
           Hrs.Max
Conn ID    Suspend Suspended Username
========== =======  HH:MM:SS ======================
9256166098      12   0: 4:13 joe
```

The attributes for active and suspended VCs are:

Conn ID
The connection id of the virtual connection. The system assigns the id when it establishes the connection.

Username
The AAA. RADIUS, or local-list user that establishes the virtual connection.

For active VCs:

Interface
The network interface that is managing the virtual connection.

Note: Do not assign IP addresses to dial-up clients using interface assignment to avoid problems caused by other users using this interface which the VC suspended.

Idle Timeout
The amount of inactive time, in seconds, after which the system will suspend the VC. This corresponds to the value of inactivity timer in the **set** command.

Connected HHH:MM:SS
The total amount of time in hours, minutes, and seconds, that the VC has been connected to an interface.

For suspended VCs:

Hrs. Max Suspended
The maximum number of hours a VC can be in suspend state before the system ends the connection. This corresponds to the value of maximum suspended time in the **set** command.

Suspended HH:MM:SS
The total amount of time in hours, minutes, and seconds, that the VC has been suspended.

dhcp-servers
Displays configured information about DHCP servers and their IP addresses.

ip-address-assignment
Display the methods by which IP addresses can be assigned to clients

ip-pool
Display the current usage of the pool.

Example:

```
DIALs Console> list ip-pool
Current IP address pools:
     Base Address      Last Address         Total          Free
     ------------      ------------         -----          ----
*    192.1.100.18      192.1.100.74            57            57
      192.2.200.1     192.2.200.250           250           250

Note: The * indicates from which block the next address will be retrieved.
```

suspended-vcs
Displays the attributes of all suspended virtual connections. See description of the **all-vcs** parameter for an explanation of the attributes.

vc-parameters
Displays the values of the vc-parameters that were set using the **set vc-parameters** command.

Reset

Use the **reset** command to dynamically activate the configuration changes made to the DIALs interface in `talk 6`.

Syntax:

reset all

dhcp-parameters

ip-address-assignment

ip-pool

vc-parameters

all Dynamically activate the DHCP, IP address assignment, and IP-pool configuration changes.

dhcp-parameters
Dynamically activate the DHCP configuration.

ip-address-assignment
Dynamically activate the IP address assignment method configuration.

ip-pool
Dynamically activate the IP address pool configuration.

vc-parameters
Dynamically updates VC config changes.

Dial-Out Interface Configuration Commands

To access the dial-out interface parameter environment:

1. Enter **talk 6** at the `*` prompt.
2. Enter **net *n*** at the `Config >` prompt.
3. Enter **encapsulator** at the `Circuit config: n>` prompt.

Table 41 lists the commands available from the `dial-out config>` prompt.

Table 41. Dial-Out Interface 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 xxvi.
Set	Defines the port name associated with a modem.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Set

Use the **set** command to define the port name for a modem.

Syntax:

set portname *name*

portname
Defines the name of the port associated with a modem. Use this name to define ***modem pools.*** The name can be up to 30 characters in length.

Default value: ALL_PORTS

Example: `dial-out config>`**set portname localcalls**

Monitoring Dial-In Interfaces

Monitoring dial-in interfaces is the same as monitoring other PPP dial circuits. For details, see “Configuring and Monitoring Point-to-Point Protocol Interfaces” in the *Access Integration Services Software User’s Guide* .

Monitoring Dial-Out Interfaces

Table 42 lists the commands available when monitoring dial-out interfaces.

Table 42. Dial-Out Interface 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 xxvi.
Clear	Resets the statistics for this dial-out interface.
List	Lists the current state of the dial-out interface, the number of bytes transmitted and received on this interface, and the client’s current parameters.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Clear

Use the **clear** command to reset the statistics for the number of octets received and transmitted by this interface.

Syntax:

clear

Example:

```
clear
Statistics reset.
```

List

Use the **list** command to display current state of the dial-out interface. The **list** command always displays the current state of the dial-out net, the time since the state change, and the number of bytes received and transmitted.

Syntax:

list

Example for inactive interface:

```
list
Dial-out Settings for current session:

Dial-out state is DOWN
Time since change           = 52 minutes and 34 seconds

Dial-out Octets transmitted = 0
Dial-out Octets received    = 0

Session down, no valid settings
```

Note: When a client connects to a dial-out port using telnet, no user name is present because the server did not perform any authentication.

Example for active interface:

```
list
Dial-out Settings for current session:

Dial-out state is UP
Time since change           = 3 seconds

Dial-out Octets transmitted = 14
Dial-out Octets received    = 765

Current user                = not available
Time allowed for user       = unlimited
Inactivity timer for port   = 10 minutes
Line speed                  = 57600
Current DTR state           = DTR ON
Current dial-out protocol   = TELNET
Options negotiated:
        Will Suppress Go Ahead
        Wont' Echo characters
```

Example for an active IBM DIALs Dial-Out client:

```
list
Dial-out Settings for current session:

Dial-out state is UP
Time since change           = 12 seconds

Dial-out Octets transmitted = 11
Dial-out Octets received    = 756

Current user                = ebooth
Time allowed for user       = unlimited
Inactivity timer for port   = 10 minutes
Line speed                  = 57600
Current DTR state           = DTR ON
Current dial-out protocol   = DIALs
```

Chapter 23. Using Thin Server Feature

This chapter describes how to use the Thin Server Feature (TSF) in the IBM 2212.

Network Station Overview

A Network Station is similar to a personal computer (PC), having a keyboard, display, and a mouse. The main difference between a Network Station and a PC is that the Network Station files reside on a network server rather than on a hard drive inside of your machine. The Network Station presents you a graphical user interface (GUI), which provides access to many resources, including emulators, remote X applications, Web browsers, applications, and printers.

The Network Station communicates using TCP/IP over a token-ring or Ethernet connection to the server. The Network Station power-on process is:

- A non-volatile random access memory resident boot monitor program is started and power on self tests are executed.
- The Network Station contacts a BootP or DHCP server which provides the Network Station with information such as its IP address, its server address(es), and the path and name of boot file. Alternatively, the Network Station may retrieve this information from values that are stored in its non-volatile random access memory.
- The Network Station uses Trivial File Transfer Protocol (TFTP), Remote File System/400 (RFS/400), or Network File System (NFS) to download the base code, such as the operating system, hardware configuration files, and application programs, from the base code server.
- The Network Station downloads the terminal-based configuration information, such as configuration for a printer that is attached to the Network Station or the Network Station's keyboard language, from the terminal configuration server.
- The Network Station presents a log-on screen. You are then able to enter a userid and password.
- The Authentication server validates your userid and password and allows access to personal user files.
- Your personalized environment preferences are downloaded.
- The Network Station displays your personalized desktop.

Refer to *IBM Network Station Manager Installation and Use*, SC41-0664, for more information about Network Stations.

Thin Server Feature Overview

One physical device may function as the BootP/DHCP server, the boot server, the terminal configuration server, and the authentication server, or each server may be a separate device. For example, you may have a Network Station connected to an AS/400 and the AS/400 acts as the BootP server, base code server, terminal configuration server, and authentication server. Alternatively, each server may be a separate physical box. For example, the Network Station may be connected to a network where an NT server is its DHCP server, an AS/400 is its base code server, another AS/400 is its terminal configuration server, and yet another AS/400 is its authentication server.

Using TSF

The Thin Server feature allows the 2212 to be a base code server. One example of why using the TSF would be desirable is illustrated by Figure 23 and Figure 24 on page 263 . In Figure 23, any file which the Network Station requires will be downloaded from the single server. When the Network Station is powered on, the download consists of several megabytes. This could be very demanding on a network infrastructure, as well as the device acting as the base code/terminal configuration server or authentication server, especially if many Network Stations are powered on simultaneously. Figure 24 on page 263 shows the network with a Thin Server used at the remote site. Many of the files associated with the Network Station boot code will be cached by the Thin Server. When the Network Station is powered on, most of the boot code will be loaded from the Thin Server and only a small amount of data will need to be transported across the network infrastructure. This reduced processing on any single server lowers network traffic and reduces the time necessary complete the power on of a Network Station.

Since files cached by the Thin Server are copies of files which reside on the master file server, as the version on the master file server gets modified, the Thin Server needs to update its version of that file. The Thin Server will verify that all of the cached files are identical to the master file server version of those files when:

1. The IBM 2212 is powered on
2. The IBM 2212 is reloaded or restarted
3. The TSF is restarted
4. The time interval specified in the TSF configuration is reached
5. An SNMP MIB action parameter triggers it
6. The TSF `talk 5` **refresh** command is issued
7. Each time a file is accessed (except TFTP). The TSF will verify that each file accessed matches the version on the master file server. When a difference is detected, that file will be updated. Then the TSF will verify that the remaining files match the master file server as well.

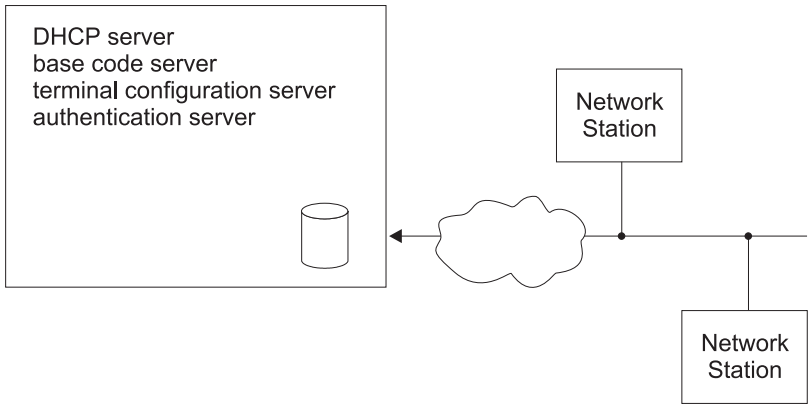


Figure 23. Remote Network Station without a Thin Server

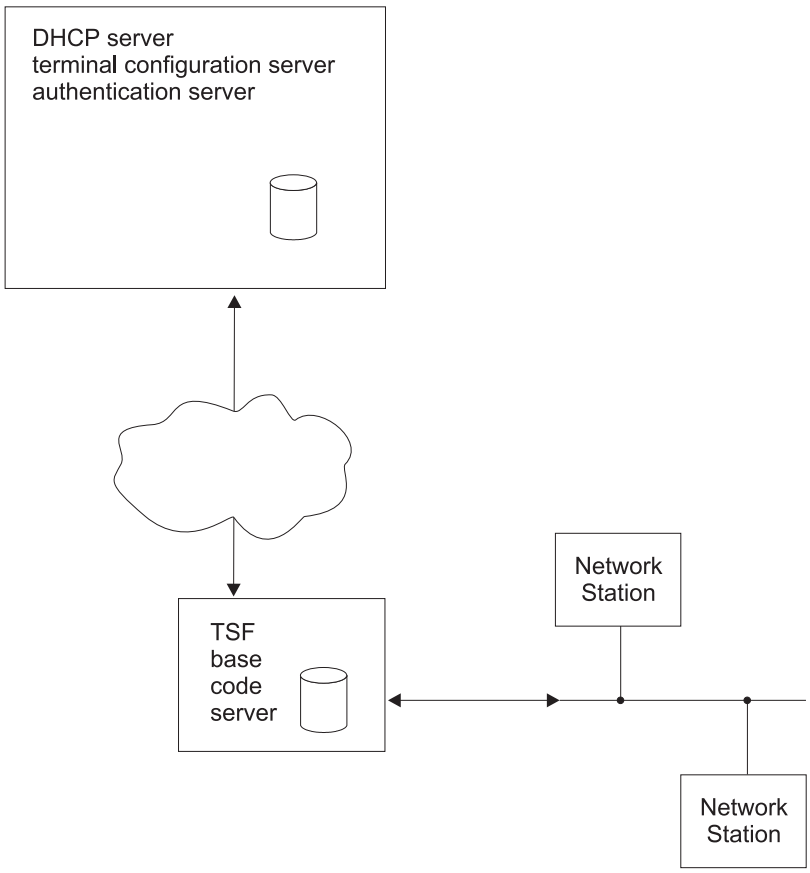


Figure 24. Remote Network Station with a Thin Server

BootP/DHCP Support

The 2212 does not itself act as a BootP/DHCP Server. The 2212 should however be configured to act as a relay agent for BootP/DHCP requests.

Refer to *IBM Network Station Manager Installation and Use*, SC41-0664, for more information about multiple server environments.

Protocols Used to Communicate with the Network Stations

The protocols used to communicate between the Network Station and its servers will be determined either by the BootP/DHCP configuration or by the Network Station NVRAM configuration. In either case, the protocols which the Network Station uses must be compatible with how the TSF is configured.

If the TSF is configured to use RFS to communicate with the master file server, then it will accept RFS and TFTP requests from the Network Stations and the TSF will not respond to any NFS requests from Network Stations.

Similarly, if the TSF is configured to use NFS to communicate with the master file server, then it will accept NFS and TFTP requests from the Network Stations and the TSF will not respond to any RFS requests from Network Stations.

Using RFS

The TSF establishes a connection to the AS/400 using RFS. When a Network Station makes a request to open a file, the TSF forwards that request to the AS/400 for authorization. If the Network Station is not authorized, TSF will not send the requested file to the Network Station. If the Network Station is authorized, and the AS/400 version of the requested file differs from the version stored on the IBM 2212 TSF, the Network Station request is relayed to the AS/400. If the file on the AS/400 is the same version as the file the TSF has cached, then the TSF will serve that file to the Network Station.

If the TSF connection to the AS/400 is unavailable, then the TSF will serve the files that it currently has cached to the Network Station.

Using TFTP

If TFTP is being used to communicate between the Network Station and the TSF, the TSF will serve Network Station requests for files if those files are available. No verification of version is made between the TSF and the master file server. If the file is not available in the TSF cache, the request from the Network Station is forwarded to the master file server.

Using NFS

If NFS is being used to communicate between the Network Station and the TSF, then when a Network Station makes a request for a file, the TSF will start serving that file if it is cached. Simultaneously, it will verify that the file is the same version as the master file server. If not, then the TSF will terminate the serving of the file and immediately start downloading the new version from the master file server.

If the TSF does not have the file cached, then the TSF will return a ″file not found″ message. In addition, if the requested file resides in a directory for which the TSF has been configured with *include subdirectories* or resides in a sub-directory under such a configured directory, then the TSF will start caching the file, if the file exists on the master file server.

File Cache Updates

The protocol used for file caching on the IBM 2212 is determined by the configuration of TSF. You will designate a master server using the **add master-file-server** command.

If you specify *rfs*, you will be prompted to supply a pre-load list file name. The pre-load list is an ASCII file which specifies the fully-qualified file name of every file that the TSF should cache.

If you specify *nfs*, you will be prompted for directory names to be cached (some defaults may be provided). When you specify a directory, you will be prompted for whether or not to include subdirectories. Specifying *no* (do not include subdirectories) will cause the TSF to pre-load all files in the specified directory into the TSF cache. Specifying *yes* (include subdirectories) will cause the TSF to NOT pre-load any files from that directory, but rather it will dynamically retrieve files from that directory and any of its subdirectories as Network Stations request those files.

Files that are in the process of being refreshed will not be sent to the Network Station during this process.

Configuring the Thin Server Environment

When the TSF is installed, there are several configurations beyond that of the TSF itself which may need to be considered. This section discusses the changes which may be necessary to the BootP/DHCP server, the master file server, the IBM 2212 BootP Relay, the IBM 2212 Internal IP address, and the IBM 2212 TSF configuration. An example of a Thin Server connecting to an AS/400 running Network Station Manager Release 2.5 is discussed in “Sample Configuration” on page 267 .
The following sections describe the Thin Server environment configuration process:

Configuration Recommendations

The following are configuration recommendations to help you get the most from the TSF:

- Use a hardfile.

  While the TSF does not require a hardfile, it will improve your performance if the TSF memory cache is configured too small (or cannot be configured large enough because of other functions in the 2212), and a hardfile will improve performance if the TSF or 2212 is restarted or reloaded.
- A maximum of 30 Network Stations is recommended.

  While the TSF will allow up to 200 Network Stations, this recommended maximum is based on what is felt to be an acceptable amount of time for the Network Stations to boot if all are IPLed simultaneously, for example if there is a power outage.
- The master file server should be a server running Network Station Manager.

  While the TSF allows the master file server IP address to be any value, it is recommended that this be the address of a device that is running Network Station Manager (NSM) so that the file structure is compatible with the Network Station and hence the TSF, and it can provide the files that the TSF will ask for.
- Define sufficient memory to contain all of the cached files in memory.

  This is required if you do not have a hardfile. If you do have a hardfile, memory access is much quicker than hardfile access. The amount of memory needed will vary depending on your specific environment. Use the `Talk 5` **list config** command to determine how large your file set is at a particular instance in time . The value displayed for *Hard File storage being used for Thin Server* is the size of your file set in kilobytes. However, if different types of Network Stations or applications are added to or removed from your environment, this value may change.

- If you are using NFS, the TSF learns which files it needs.

  This learning process may take several Network Station power-on sequences for TSF to identify all the needed files.

Configuring the BootP/DHCP Server

When running Network Station Manager Release 3, DHCP is required when you are using a Thin Server. If you are using an AS/400 as the master file server, then Network Station Manager Release 2.5 may be used, in which case BootP may be used instead of DHCP.

For BootP, only one server address can be specified. That address is specified by using the **sa** tag. This tag may or may not already exist in the BootP record for a given Network Station. If it does not exist, then create it and set the value to the 2212s Internal IP address. If it already exists, then change it to the 2212's Internal IP address.

For DHCP, the fields that may need to be modified when the Thin Server is used are as follows:

- Option 66 or bootstrap server - base code server IP address

  This value should be set to the IBM 2212 Internal IP address
- Option 211 - protocol to use for the base code server

  If the Thin Server is being configured for a master-file-server type of NFS, then this must be either *nfs* or *tftp*. If the Thin Server is begin configured for a master-file-server type of RFS, then this must be either *rfs/400* or *tftp*.
- Option 212 - terminal configuration server

  This address should be the same as the master-file-server IP address. This address SHOULD NOT be the Thin Server's IP address.

For more details about how NSs interact with BootP and DHCP, refer to *IBM Network Station Manager Installation and Use*, SC41-0664.

Configuring the Server for the Thin Server Environment

For RFS, the pre-load list must be installed on the AS/400. The preload list is available on the internet at `http://www.networking.ibm.com/netprod.html#routers`. You should ftp the LoadList.file from this site and place it in `/QIBM/ProdData/OS400/NetStationRmtController` on the AS/400. The NetStationRmtController directory may need to be created.

For NFS, no special changes are necessary for the Thin Server.

Configuring BootP Relay

The IBM 2212's BootP Relay agent should be enabled and the appropriate BootP and DHCP servers should be configured so the BootP Relay will forward to those servers. Refer to *Access Integration Services Software User's Guide* for more information.

Configuring the Internal IP Address

If an Internal IP address already exists, no special change is necessary. If no Internal IP address is currently specified, one should be specified. Refer to *Protocol*

Configuration and Monitoring Reference Volume 1 for more information.

Configuring the TSF

Use the commands discussed in “Chapter 24. Configuring and Monitoring Thin Server Function” on page 273 to configure the Thin Server.

Minimally, the following commands must be entered:

1. **load add package thin-server**
2. **set mode enable**
3. **add master-server**

Sample Configuration

The following example configures a TSF going to an AS/400 that is running Network Station Manager R2.5.

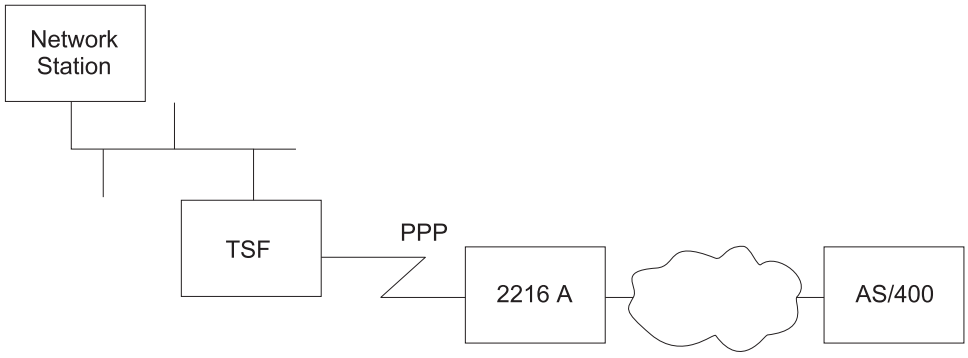


Figure 25. TSF Sample Configuration

This discussion describes configuring the Thin Server Feature based on the above network and with the following assumptions:

- The AS/400 will be the BootP server.
- The 2216 A is a router (no TSF configured and no special configuration for TSF).
- The network IP connectivity has been validated, i.e. the AS/400 can PING the IBM 2212 (TSF) and the IBM 2212 can PING the AS/400.
- BootP Relay is NOT currently enabled in the IBM 2212 (TSF)
- An IP Internal Address is NOT currently configured in the IBM 2212 (TSF)

Configuring the AS/400

BootP (NSM Release 2.5)

1. Use NSM to define the NS
2. ftp the BootP table to a system which has an ASCII editor

```
c:\>ftp as400a
Connected to as400a.raleigh.ibm.com.
220-QTCP at AS400A.RALEIGH.IBM.COM.
220 Connection will close if idle more than 5 minutes.
Name (as400a:goofy): qsecofr
331 Enter password. Password:
```

```
230 QSECOFR logged on.
ftp> ascii
ftp> get qusrsys/qatodbtp.bootptab bootp.tab
ftp> quit
```

3. Edit the file using an ASCII editor, adding a ″sa″ tag with the 2212 (TSF)'s Internal IP address specified:

```
OLD LINE
--------
NSEN106:ip=192.9.250.36:bt=IBMNSM:ht=1:ha=00.00.A7.01.2E.35:
sm=255.255.248.0:gw=192.9.250.6:bf=KERNEL:
hd=/QIBM/PRODDATA/NETWORKSTATION

MODIFIED LINE
-------------
NSEN106:ip=192.9.250.36:bt=IBMNSM:ht=1:ha=00.00.A7.01.2E.35:
sm=255.255.248.0:gw=192.9.250.6:bf=KERNEL:
hd=/QIBM/PRODDATA/NETWORKSTATION:sa=192.9.250.6
```

   where 192.9.250.6 is the 2212 (TSF)'s Internal IP address

4. ftp the BootP table back to the AS/400

```
c:\> ftp as400a
Connected to as400a.raleigh.ibm.com.
220-QTCP at AS400A.RALEIGH.IBM.COM.
220 Connection will close if idle more than 5 minutes.
Name (as400a:goofy): qsecofr
331 Enter password.
Password:
230 QSECOFR logged on.
ftp> ascii
ftp> put bootp.tab qusrsys/qatodbtp.bootptab
ftp> quit
```

Setting up the Pre-load List

You can obtain a Pre-load list from the internet:
`http://www.networking.ibm.com/netprod.html#routers`

Once you have the preload list you can ″ftp″ it to the AS/400.

1. Make sure your local directory is set to the location of the ″LoadList.file″.
2. ftp to your AS/400 - ″test400″ is the name of the AS/400 in this example.

```
ftp test400
Connected to test400.raleigh.ibm.com.
Name (test400:root): qsecofr
Enter password.
Password:
QSECOFR logged on.
```

3. Change to the correct directory on the target AS/400:

```
ftp> cd /
Current directory changed to /.
ftp> cd qibm/proddata/os400/
Current directory changed to /qibm/proddata/os400.
ftp> dir
PORT subcommand request successful.
 List started.
QTCP            34816 04/30/97 02:50:36 *DIR     REXEC/
QSECOFR         33792 07/24/98 08:04:55 *DIR     NetStationRmtController/
 List completed.
```

4. If the directory ″NetStationRmtController″ does not exist you will need to create it.

```
ftp> MKD
(directory - name) NetStationRmtController
Created directory /qibm/proddata/os400/netstationrmtcontroller
```

5. Change to the NetStationRmtController directory:

```
ftp> cd NetStationRmtController
Current directory changed to /qibm/proddata/os400/Netstationrmtcontroller.
```

6. Transfer the file to the AS/400:

```
ftp> ascii
Representation type is ASCII nonprint.
ftp> put LoadList.file
 PORT subcommand request successful.
 Sending file to /qibm/proddata/os400/Netstationrmtcontroller
 File transfer completed successfully.
```

Configuring TCP/IP

Your TCP/IP configuration will depend on your specific environment.

Configuring the IBM 2212 (TSF)

BootP Relay

1. Determine if BootP relay is already configured:

```
*
*
t 6
Config>protocol ip
Internet protocol user configuration
IP config>list bootp
BOOTP forwarding: enabled
Max number of BOOTP forwarding hops: 4
Min secs of retry before forwarding: 0
Configured BOOTP servers:      192.9.220.21
IP config>
```

2. If it is not already enabled, then enable it:

```
IP config>enable bootp
Maximum number of forwarding hops [4]?
Minimum seconds before forwarding [0]?
IP config>
```

3. If your Network Station BootP or DHCP server is not in the list of configured servers, then add it:

```
IP config>add bootp-server
BOOTP server address [0.0.0.0]? 9.37.121.6
IP config>
```

Internal IP Address

1. Determine if an internal IP address has already been configured:

```
 Config>protocol ip
 Internet protocol user configuration
 IP config>list addresses
 IP addresses for each interface:
    intf     0   9.37.177.97      255.255.248.0    Local wire...
    intf     1   192.9.220.2      255.255.255.0    Local wire...
    intf     2   192.9.250.6      255.255.255.0    Local wire...
    intf     3   192.9.222.2      255.255.255.0    Local wire...
    intf     4                                     IP disabled...
    intf     5                                     IP disabled...
    intf     6   192.9.223.2      255.255.255.0    Local wire...
 IP config>
```

2. Configure the Internal IP Address.

```
IP config>set internal-ip-address
Internal IP address [192.9.223.2]? 192.9.250.6
IP config>
```

3. List the addresses again.

```
IP config>list addresses
IP addresses for each interface:
   intf     0   9.37.177.97      255.255.248.0    Local wire
   intf     1   192.9.220.2      255.255.255.0    Local wire
   intf     2   192.9.250.6      255.255.255.0    Local wire
   intf     3   192.9.222.2      255.255.255.0    Local wire
   intf     4                                     IP disabled
   intf     5                                     IP disabled
   intf     6   192.9.223.2      255.255.255.0    Local wire
Internal IP address: 192.9.250.6
IP config>
```

Thin Server Feature

1. Add load package thin-server

   Before the Thin Server feature can be configured, you must add the load package.

   First, check to make sure that the thin server package is available.

```
Config>load list available
Available Packages
------------------
appn package
tn3270e package
thin-server package
Config>
```

   If it is not available, then you need to get the correct software version before proceeding.

   If it is available, verify that the package is not already loaded.

```
Config>load list configured
Configured Packages
-------------------
thin-server package
Config>
```

   If it is already loaded/configured (as shown above), then you can proceed to configuring TSF. If it is not already loaded, then you need to add the Thin Server package:

```
Config>load add package thin-server
thin-server package configured successfully
This change requires a reload.
Config>
```

2. Reload

   If you had to add the Thin Server package, then you must now write the configuration and reload the IBM 2212.

3. Set mode enable

   When the package is loaded, the Thin Server is initially disabled. The mode must be set to enabled before any other Thin Server parameters can be configured.

```
*
*
t 6
```

```
Config>feature tsf
Thin server config>set mode enable

Thin server feature (TSF) is fully enabled once
you have entered a Master File Server for either
RFS or NFS. Please add a master-file-server if
one is not already configured.
Thin server config>
```

4. Add master-file-server.

   Once the Thin Server feature is enabled, the master file server must be configured. In this case, the master file server is an AS/400 so we will add an RFS master file server. For this network, the default TFTP timeout and retry parameters are adequate.

   ```
   Thin server config>add master-file-server rfs-as400
   File Server IP address [0.0.0.0]? 9.37.100.68
   TFTP Packet Timeout in seconds (5 - 10) [5]?
   TFTP Max Retry Limit (1 - 10) [1]? 7
   TFTP Max Segment Size in bytes (valid values are 512, 1024, 2048, 4096, 8192) [8192]?
   Pre-load File name [/QIBM/ProdData/OS400/NetstationRmtController/Load list.file]?
   Thin server config>
   ```

   Our AS/400's IP address on the Token-Ring interface is 9.37.100.68. When we installed the pre-load list file onto the AS/400 we assigned its name to match the Thin Server default name, so that does not need to be modified.

5. Set time-to-refresh-pre-load-list (optional)

   The default for the time of day to perform the refresh is 1:00 AM. This was chosen to minimize any performance impacts if large files have been modified and need to be downloaded by the Thin Server.

6. Set interval-pre-load-list (optional)

   The default interval for verifying the cached files are at the same level as the master-file-server is every day. The value for this parameter and the time-to-refresh-pre-load-list parameter determine how often the files are verified. If the network station files change infrequently, then perhaps you would want to set these to only refresh once a week or once a month.

7. Set memory (optional).

   The default memory of a 16 MB RAM cache for file caching should be sufficient. Once several Network Stations are using TSF, see "Configuration Recommendations" on page 265 for recommended values.

8. Set hard file (optional)

   A hard-file is recommended. If you do not have a hard file, then this parameter should be set to *no*.

Chapter 24. Configuring and Monitoring Thin Server Function

This chapter describes how to use the Thin Server Function (TSF) configuration and operating commands and includes the following sections:

Accessing the TSF Configuration Environment

Use the following procedure to access the TSF configuration process.

1. At the OPCON prompt, enter **talk 6**. (For more detail on this command, refer to "The OPCON Process and Commands" in *Access Integration Services Software User's Guide*.) 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 **Return** again.
2. At the CONFIG prompt, enter the **feature tsf** command to get to the `Thin server config>` prompt.

TSF Configuration Commands

To configure TSF, enter the commands at the `Thin server config>` prompt.

Table 43. TSF 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 xxvi.
Add	Adds master file server (RFS or NFS).
Delete	Deletes master file server (RFS or NFS).
List	Lists the thin server configuration.
Modify	Modifies master file server (RFS or NFS).
Set	Sets the thin server parameters.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Add

Use the **add** command to add a master file server configuration.

If you select *nfs* as the master-file-server type, the Thin Server will use NFS to communicate with the master file server and synchronize files and NSs can communicate with the Thin Server using TFTP or NFS. If you select *rfs* as the master-server type, then the Thin Server will use RFS to communicate with the

master file server and synchronize files and NSs can communicate with the Thin Server using TFTP or RFS.

Syntax:

add master-file-server nfs-s390
nfs-nt
nfs-aix
nfs-other
rfs-as400

nfs-s390

Used when the TSF is connected to a S/390.

file server IP address

Valid Values: any valid IP address

Default Value: none

tftp packet timeout

Valid Values: 5 - 10 seconds

Default Value: 5

tftp maximum retry limit

Valid Values: 1 - 10

Default Value: 1

maximum segment size

Specifies the maximum packet segment size.

Valid Values: 512, 1024, 2048, 4096, 8192 (bytes)

Default Value: 8192

additional Include subdirectories

Specifies whether additional Included subdirectories are to be added. Additional subdirectories may be specified if the TSF needs to cache files that are not in the default directories.

Valid Values: yes or no

Default Value: yes

additional Include subdirectory path

Specifies the path of the Include subdirectory to be added.

Valid Values: a-z, A-Z, 0-9, ., _, —, /

Default Value: none

include all subdirectories under this directory

Specifies whether all nested subdirectories in the specified additional subdirectory path will be included.

Valid Values:

- No

  The TSF will pre-load all files in the specified directory.
- Yes

The TSF will not pre-load any files in the specified directory. Instead the TSF will load files from the directory and any of its sub-directories as needed.

Default Value: no

nfs-nt Used when the TSF is connected to Windows-NT.

file server IP address

Valid Values: any valid IP address

Default Value: none

tftp packet timeout

Valid Values: 5 - 10 seconds

Default Value: 5

tftp maximum retry limit

Valid Values: 1 - 10

Default Value: 1

maximum segment size

Specifies the maximum packet segment size.

Valid Values: 512, 1024, 2048, 4096, 8192 (bytes)

Default Value: 8192

additional Include subdirectories

Specifies whether additional Included subdirectories are to be added.

Valid Values: yes or no

Default Value: yes

additional Include subdirectory path

Specifies the path of the Include subdirectory to be added.

Valid Values: a-z, A-Z, 0-9, ., _, —, /

Default Value: none

include all subdirectories under this directory

Specifies whether all nested subdirectories in the specified additional subdirectory path will be included.

Valid Values:

- No

  The TSF will pre-load all files in the specified directory.

- Yes

  The TSF will not pre-load any files in the specified directory. Instead the TSF will load files from the directory and any of its sub-directories as needed.

Default Value: no

nfs-aix

Used when the TSF is connected to AIX.

file server IP address

Valid Values: any valid IP address

Default Value: none

tftp packet timeout

Valid Values: 5 - 10 seconds

Default Value: 5

tftp maximum retry limit

Valid Values: 1 - 10

Default Value: 1

maximum segment size
Specifies the maximum packet segment size.

Valid Values: 512, 1024, 2048, 4096, 8192 (bytes)

Default Value: 8192

additional Include subdirectories
Specifies whether addtional Included subdirectories are to be added.

Valid Values: yes or no

Default Value: yes

additional Include subdirectory path
Specifies the path of the Include subdirectory to be added.

Valid Values: a-z, A-Z, 0-9, ., _, —, /

Default Value: none

include all subdirectories under this directory
Specifies whether all nested subdirectories in the specified additional subdirectory path will be included.

Valid Values:

- No

  The TSF will pre-load all files in the specified directory.
- Yes

  The TSF will not pre-load any files in the specified directory. Instead the TSF will load files from the directory and any of its sub-directories as needed.

Default Value: no

nfs-other
Used when you want to manually designate all of the subdirectories.

file server IP address

Valid Values: any valid IP address

Default Value: none

tftp packet timeout

Valid Values: 5 - 10 seconds

Default Value: 5

tftp maximum retry limit

Valid Values: 1 - 10

Default Value: 1

maximum segment size
Specifies the maximum packet segment size.

Valid Values: 512, 1024, 2048, 4096, 8192 (bytes)

Default Value: 8192

additional Include subdirectories
Specifies whether addtional Included subdirectories are to be added.

Valid Values: yes or no

Default Value: yes

additional Include subdirectory path
Specifies the path of the Include subdirectory to be added.

Valid Values: a-z, A-Z, 0-9, ., _, —, /

Default Value: none

include all subdirectories under this directory
Specifies whether all nested subdirectories in the specified additional subdirectory path will be included.

Valid Values:

- No

  The TSF will pre-load all files in the specified directory.
- Yes

  The TSF will not pre-load any files in the specified directory. Instead the TSF will load files from the directory and any of its sub-directories as needed.

Default Value: no

rfs-as400
Used when the TSF is connected to an AS/400.

file server IP address

Valid Values: any valid IP address

Default Value: none

tftp packet timeout

Valid Values: 5 - 10 seconds

Default Value: 5

tftp maximum retry limit

Valid Values: 1 - 10

Default Value: 1

maximum segment size
Specifies the maximum packet segment size.

Valid Values: 512, 1024, 2048, 4096, 8192 (bytes)

Default Value: 8192

pre-load file name
Specifies the name and path of the pre-load file.

Valid Values: a-z, A-Z, 0-9, ., _, —, /**Default Value:** /QIBM/ProdData/OS400/NetStationRmtController/LoadList.file

Example: For NFS

```
Thin server config> add master-file-server nfs
 File Server IP address [0.0.0.0]? 10.22.55.94
 TFTP Packet Timeout in seconds (5 - 10) [5]?6
 TFTP Max Retry Limit (1 - 10) [1]? 7
 TFTP Max Segment Size in bytes (valid values are 512, 1024, 2048, 4096, 8192) [8192]? 512

Default Include Directories:

    Include Directory List Follows:

    Include
      all
    Subdirs?   Directory Names
    --------   ---------------------------------
       N       /hfs/usr/lpp/nstation/standard
       Y       /hfs/usr/lpp/nstation/standard/mods
       Y       /hfs/usr/lpp/nstation/standard/nls
       Y       /hfs/usr/lpp/nstation/standard/fonts
       Y       /hfs/usr/lpp/nstation/standard/java
       Y       /hfs/usr/lpp/nstation/standard/keyboards
       Y       /hfs/usr/lpp/nstation/standard/proms
       Y       /hfs/usr/lpp/nstation/standard/X11
       Y       /hfs/usr/lpp/nstation/standard/configs
       Y       /hfs/usr/lpp/nstation/standard/SysDef
       Y       /hfs/usr/lpp/nstation/standard/zoneinfo
   Do you want additional Include Subdirectories (Y)es (N)o? [y]

Include Subdirectory [   ]? /usr/lpp/nstation/standard/whatever
Include all subdirectories under this directory (Y)es or (N)o? [n]

Do you want additional Include Subdirectories (Y)es (N)o? []
```

Example: For RFS

```
Thin server config> add master-file-server rfs
 File Server IP address [0.0.0.0]? 01.01.01.98
 TFTP Packet Timeout in seconds (5-10) [5]? 6
 TFTP Max Retry Limit (1-10) [1]? 7
 TFTP Max Segment Size in bytes (valid values are 512, 1024, 2048, 4096, 8192) [8192]? 512

 Pre-Load File name
 [/QIBM/ProdData/OS400/NetStationRmtController/LoadList.file]?
```

Delete

Use the **delete** command to remove a master file server configuration.

Syntax:

delete nfs

rfs

nfs Used when any of the NFS master file servers is configured.

rfs Used when the TSF is configured for the RFS master file server.

List

Use the **list** command to display the TSF configuration.

Syntax:

list all

Example:

```
Thin server config> list all

Thin Server Feature:
     Enabled
     Interval to refresh cache in day(s):  2
     Time of day (military time) to refresh cache: 0800
     Megabytes used for Thin Server RAM cache:  4
     Use Hard File:  YES

Master Thin Server list:
     Server IP Address: 9.37.111.12
     Server Protocol: NFS
     TFTP Packet Timeout in seconds:  10
     TFTP Retry Limit              :  6
     TFTP Max Segment Size in bytes:  512


     Initial directories setup for server type: NFS-AIX

  NFS Include Directory List Follows:

     Include
       all
     subdirs?    Directory Names
     --------    ------------------------------------------

        N        /usr/netstation
        Y        /usr/netstation/mods
        Y        /usr/netstation/nls
        Y        /usr/netstation/fonts
        Y        /usr/netstation/java
        Y        /usr/netstation/keyboards
        Y        /usr/netstation/proms
        Y        /usr/netstation/X11
        Y        /usr/netstation/configs
        Y        /usr/netstation/SysDef
        Y        /usr/netstation/zoneinfo
```

Modify

Use the **modify** command to modify a master file server configuration.

Syntax:

modify master-file-server nfs

rfs

nfs Used when one of the NFS master file servers has been configured.

rfs Used when the TSF is configured for the RFS master file server.

Example: For NFS

```
Thin server config> modify master-file-server nfs
 File Server IP address [         ]? 10.22.55.94
 TFTP Packet Timeout in seconds (5 - 10) [5 ]? 10
 TFTP Max Retry Limit (1 - 10) [1]? 6
 TFTP Max Segment Size in bytes valid values are 512, 1024, 2048, 4096,
 8192) [8192]? 1024

 Include subdirectory [/usr/lpp/tcpip/nstation/standard, (Y)es or (N)o [Y]?
        Include all subdirectories under this directory (Y)es or (N)o [N]?

 Include subdirectory [/usr/lpp/tcpip/nstation/standard/mods], (Y)es or (N)o [Y]?
        Include all subdirectories under this directory (Y)es or (N)o [N]?

 Include subdirectory [/usr/lpp/tcpip/nstation/standard/nls], (Y)es or (N)o [Y]?
        Include all subdirectories under this directory (Y)es or (N)o [N]?

 Include subdirectory [/usr/lpp/tcpip/nstation/standard/fonts], (Y)es or (N)o [Y]?
        Include all subdirectories under this directory (Y)es or (N)o [N]?

 Include subdirectory [/usr/lpp/tcpip/nstation/standard/java], (Y)es or (N)o [Y]?
        Include all subdirectories under this directory (Y)es or (N)o [N]?

 Include subdirectory [/usr/lpp/tcpip/nstation/standard/keyboards], (Y)es or (N)o [Y]?
        Include all subdirectories under this directory (Y)es or (N)o [N]?

 Do you want additional Include Subdirectories (Y)es or (N)o? n
```

Example: For RFS

```
Thin server config> modify master-file-server rfs
 File Server IP address [09.09.255.253 ]? 01.01.01.98
 TFTP Packet Timeout in seconds [5 ]? 10
 TFTP Retry Limit [5 ]? 6
 TFTP Max Segment Size in bytes [8192]? 512

 Pre-Load File name
 [/QIBM/ProdData/OS400/NetStationRmtController/LoadList.file]?
```

Set

Use the **set** command to set TSF configuration parameters.

Syntax:

set

- mode
- interval-pre-load-list
- time-to-refresh-pre-load-list
- memory-cache
- hard-file

mode Specifies the mode of the TSF.

Valid Values:

- enable

  A mode of enable means that the TSF is fully functional and will serve cached files to Network Stations.

- disable

  A mode of disable means that the TSF is not active and will not respond to any Network Stations. Network Stations should be configured to communicate directly to the server.

- passthru

  A mode of passthru is only valid when using RFS. Passthru will allow the Network Station to contact the TSF, but will always get files from the master file server.

Default Value:

interval-pre-load-list
Specifies the interval to refresh the pre-load list in days.

Valid Values: 00 - 365

Default Value: 01

time-to-refresh-pre-load-list
Specifies the time of day in military (24-hour time) to refresh cache.

Valid Values: 0001 - 2400

Default Value: 0100

memory-cache
Specifies the amount of memory in megabytes for Thin Server RAM cache. When using a hard file, this value should be chosen so as to balance the performance of TSF with other functions in the IBM 2212. When not using a hard file, this value should be large enough to hold all cached files. For more information, see “Configuration Recommendations” on page 265.

Valid Values: 8 - 64 Megabytes

Default Value: 16

hard-file
Specifies whether to use the hard file.

Valid Values: yes or no

Default Value: yes

Example:

```
Thin server config> set mode passthru
This server feature (TSF) is passthru
Thin server config> set interval-pre-load-list
Interval to refresh the Pre-Load list in days (00-365) [01]? 1
Thin server config> set time-to-refresh-pre-load-list
Time of day to refresh cache in military time (0001-2400) [0100] 0800
Thin server config> set memory-cache
Amount of memory in megabytes for Thin Server RAM cache (8-64MB) [8]
Thin server config> set hard-file
Use the Hard File  (Y)ex N(o) [Y]? yes
```

Accessing the TSF Monitoring Environment

Use the following procedure to access the TSF monitoring commands. This process gives you access to the TSF *monitoring* process.

TSF Configuration Commands (Talk 6)

1. At the OPCON prompt, enter **talk 5**. (For more detail on this command, refer to *The OPCON Process and Commands* in the Access Integration Services Software User's Guide.) 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 **Return** again.

2. At the + prompt, enter the **f tsf** command to get you to the `Thin-Server>` prompt.

   Example:

```
+ f tsf
Thin-Server>
```

TSF Monitoring Commands

This section describes the TSF monitoring commands.

Table 44. TSF 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 xxvi.
Delete	Deletes a file from Thin Server feature file cache.
Flush	Flushes the Thin Server feature file cache.
List	Displays Thin Server settings and values.
Refresh	Refreshes the cache.
Reset	Resets counters.
Restart	Restarts the Thin Server process.
Set	Changes Thin Server feature settings.
Exit	Returns you to the previous command level. See "Exiting a Lower Level Environment" on page xxvi.

Delete

Use the **delete** command to remove a file from the Thin Server feature file cache.

Syntax:

delete *filename*

filename

Specifies the name of the file to be remove from the file cache.

Valid Values:

Default Value: none

Example:

```
Thin-Server> delete
Enter filename to delete from the File Cache: /ibm/prod/ns/5494.dat
Are you sure that you want to delete this file? (Y/ [N]): y
File successfully deleted
```

Flush

Use the **flush** command to flush the TSF memory and hard disk cache space. The **flush** command will erase all cached files. The Thin Server cache will be updated on the next refresh from the Master Server. Network Stations may experience delays until the refresh is completed.

Syntax:

flush

Example:

```
Thin-Server> flush
The FLUSH command will erase all cached files.
  The Thin Server cache will be updated on the next refresh
  from the Master Server.  Network Stations may experience
  delays until the refresh is completed.
Are you sure you really want to do this? (Y/ [N]: y
All Thin Server cached files have been flushed
```

List

Use the **list** command to display TSF parameter settings.

Syntax:

list cached-files
config
file-access-counters
file-refresh-counters
pre-load-list
tftp-counters
ts-counters

Example:

```
Thin-Server> list cached-files

Cached
File Name     File Size  Time Stamp         Flags  Host File Name
------------  ---------  -----------------  -----  ----------------
00000026.DAT      2729   04/08/98 13:35:07   RYY   /QIBM/ProdData/OS400/Netstat
ionRmtController/Loadlist.file
00000002.DAT   2049220   09/16/97 08:55:39   RYU   /QIBM/PRODDATA/NETWORKSTATIO
N/KERNEL
                 10060   03/04/97 16:12:44   RY-   /QIBM/PRODDATA/NETWORKSTATIO
N/FONTS/PCF/MISC/7X14B.PCF
    List is Complete
```

The flags have the following meaning:

- WhereFrom
  - R = RFS Client
  - N = NFS Client
  - - = None
- InTable

  - - = Not in Table
  - u (or m) = About to Update
  - Y = In the Table
- FileState
  - - = Not on Disk
  - D = Dirty
  - A = Update Aborted
  - u = About to Update
  - U = Update in Progress
  - Y = On the Disk and Available

Common combinations of the last two flags (all three flags shown for clarity) are:

- RYY - good file
- RuY - full refresh in progress, this file hasn't been verified yet
- RYU - this file is being updated

Example: For RFS

```
Thin-Server> list config

Thin Server Configuration:
    Thin Server function is:                          Enabled
    Interval to refresh Pre-Load List (#days):        3
    Time of day (Military) to refresh Pre-Load List: 23:59:00
    Memory (KB) currently using for RAM cache:        14
    Maximum memory (KB) configured for RAM cache:     32
    Use Hardfile?:                                    Yes
    Hard File storage defined for Thin Server:        20
    Hard File storage being used for Thin Server:     14
    Number of Files Cached:                           8
    Master Server IP address:                         9.67.43.69
    TFTP Packet Timeout Value:                        10
    TFTP Max Retries:                                 4
    TFTP Max Segment Size:                            1024

    Thin Server Sync Protocol:                        RFS
    Name of Pre-Load List file:
        /QIBM/ProdData/OS400/NetstationRmtController/Loadlist.file
```

Example: For NFS

```
Thin-Server> list config

Configuration:
    Thin Server function is:                          Enabled
    Interval to refresh Pre-Load List (#days):        7
    Time of day (Military) to refresh Pre-Load List: 23:59:00
    Memory (KB) currently using for RAM cache:        14
    Maximum memory (KB) configured for RAM cache:     32
    Use Hardfile?:                                    Yes
    Hard File storage defined for Thin Server:        64
    Hard File storage being used for Thin Server:     20
    Number of Files Cached:                           12
    Master Server IP address:                         9.67.43.34
    TFTP Packet Timeout Value:                        5
    TFTP Max Retries:                                 6
    TFTP Max Segment Size:                            512

    Thin Server Sync Protocol:                        NFS
    Include Directory List Follows:
```

```
    Include
      all
    subdirs?   Directory Name(s)
    --------   ---------------------------------------------
       N       /ibm/mount/point/include/
       N       /ibm/mount/point/include/sub1
       Y       /ibm/mount/point/include/sub2
```

Example:

```
Thin-Server> list file-access-counters

Disk Statistics/Counters:
    Number of files currently open:               20
    Number of Total File Opens:                   23
    Number of Open Fails when File is Locked:      1
    Number of Read misses - Version Mismatch:      4
    Number of Read misses - File Not Present:      3
    Number of Write misses - Hard File Full:       4
```

Example:

```
Thin-Server> list file-refresh-counters

File Refresh Statistics/Counters:
    Number of Refreshes:             6
    Number of Refresh Failures:      2
    Number of Files Refreshed:      14
    Date/Time of Last File Update:  11/11/97 22:21:11
```

Example:

```
Thin-Server> list pre-load-list
 <display of pre-load list raw file>
List of Pre-Load List File is Complete
```

Example:

```
Thin-Server> list tftp-counters

TFTP Statistics/Counters
    Number of Total TFTP Clients:                          3
    Number of Current TFTP Clients:                        2
    Number of Files Served:                               22
    Number of Files Served by Master Server:              22
```

Example: For RFS

```
Thin-Server> list ts-counters

Thin Server Statistics/Counters
    Number of Total RFS Clients:                           3
    Number of Current RFS Clients:                         2
    Number of Files Served:                               22
    Number of Files Served by Master Server:              22
    Number of NS Port Mapper socket accepts:               7
    Number of NS Port Mapper sockets currently active/open:  4
    Number of NS Server socket accepts:                    2
    Number of NS 8473 sockets currently active/open:       1
    Number of NS Login socket accepts:                     3
    Number of NS 8476 sockets currently active/open:       1
    Number of RFS writes to a Thin Server cached file:     0
```

Example: For NFS

TSF monitoring Commands (Talk 5)

```
Thin-Server> list ts-counters

Thin Server Statistics/Counters
    Number of NFS Server Reads:                          13
    Number of NFS Server Read Directories:                8
    Number of Unsupported NFS Requests:                   2
    Number of total NFS Mounts:                          22
    Number of current NFS Mounts:                         7
    Number of total NFS clients:                         15
    Number of current NFS Clients:                        4
```

Refresh

Use the **refresh** command to force a refresh of the cache.

Syntax:

refresh

Example:

```
Thin-Server> refresh

Force a refresh of the cache ? (Y/ [N]): y

Thin Server cache has been refreshed
```

Reset

Use the **reset** command to dynamically reset counters.

Syntax:

reset all
file-access-counters
file-refresh
tftp-counters
ts-counters

Example:

```
Thin-Server> reset all

All Thin Server feature counters have been reset
```

Restart

Use the **restart** command to restart the TSF process.

Syntax:

restart

Example:

```
Thin-Server> restart

Restart Thin Server? (Y/ [N]): y

Thin Server has been restarted
```

Set

Use the **set** command to set the TSF caching mode.

Syntax:

set mode

mode Specifies the mode of the TSF. See “Set” on page 280.

Valid Values:

- enable
- disable
- passthru

Example:

```
Thin-Server> set mode ?

DISABLED
ENABLED
PASSTHRU

Thin-Server> set mode disable

Thin Server caching is now disabled
```

TSF monitoring Commands (Talk 5)

Chapter 25. Configuring and Monitoring VCRM

Virtual Circuit Resource Manager (VCRM) is a feature that supports Resource ReSerVation Protocol (RSVP), which is described in "Using RSVP" and "Configuring and Monitoring RSVP" in the *Protocol Configuration and Monitoring Reference Volume 1*. Based upon the reservation request from RSVP, VCRM creates the connection for the data flow over the physical interface. To do this, VCRM must first determine whether enough bandwidth exists to accommodate the reservation.

Note: If you are using WAN interfaces such as frame relay or X.25, you need to set the line speed so that VCRM knows how much bandwidth is available. The procedure for setting the line speed is described in the Frame Relay and X.25 interface configuration and monitoring chapters of the *Access Integration Services Software User's Guide*.

If the interface is a PPP link, LAN, or WAN, VCRM uses software queuing of the QoS and best-effort packets to prioritize the packets on the outbound link.

This chapter includes the following sections:

Accessing the VCRM Configuration Environment

To access the VCRM configuration environment, enter the following command at the `Config>` prompt:

```
Config> feature vcrm
VC & Resource Management config console
  --Currently no configurable objects.
Config>
```

The purpose of the message displayed is to indicate that VCRM cannot be separately configured. Enabling RSVP enables VCRM, which obtains its parameters from the RSVP configuration.

Accessing the VCRM Monitoring Environment

To access the VCRM monitoring environment, type

```
* t 5
```

Then, enter the following command at the **+** prompt:

```
+ feature VCRM
VCRM console
VCRM Console>
```

The `VCRM Console>` prompt appears.

VCRM Monitoring Commands

This section describes the VCRM monitoring commands. Enter these commands at the `VCRM Console>` prompt.

Table 45. VCRM 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 xxvi.
Clear	Resets the queue statistics.
Queue	Shows software queuing statistics.
Exit	Returns you to the previous command level. See “Exiting a Lower Level Environment” on page xxvi.

Clear

Use the **clear** command to reset the software queue statistics.

Syntax:

clear

See the **queue** command for an example of the **clear** command.

Queue

Use the **queue** command to show the software queuing of the traffic flows .

Syntax:

queue

The following list defines the terms used in displaying software queues:

Quota Amount of bandwidth reserved. Originally, best-effort (B.E.) has all the quotas. When a reservation is made, the reserved bandwidth (b/w) is shifted from the B.E. quota to the QoS quota.

Max-q Maximum queue length, stated in packets.

Curr-q
Current queue length, stated in packets.

In quota
Packets or kilobytes sent within the allocated bandwidth.

Outside quota
Packets or kilobytes sent outside of the allocated bandwidth, when idle bandwidth was available.

Packets/bytes dropped
Packets or bytes dropped by software queueing.

DLC packets/bytes dropped
Packets or bytes dropped by DLC after the packets have gone through the software queue.

Example:

```
*t 5

+feature vcrm
VCRM console
VCRM Console>?
CLEAR
QUEUE
EXIT
VCRM Console>queue
Flow-control Queues at sys-clock 346781 Second:
---------
Intf    B.E. Quota:       10000 Kbps            QoS Quota:        0     Kbps
0/Eth   B.E. Max-q        0                     QoS Max-q         0
        B.E. curr-q       0                     QoS curr-q        0
        B.E. pkts/Kbytes sent:                  QoS pkts/Kbytes sent:
        in quota:        54169/   3926          in quota:            0/      0
        outside quota:       0/      0          outside quota:       0/      0
        B.E. pkts/bytes dropped: 0/0            QoS pkts/bytes dropped:  0/0
        DLC pkts/bytes dropped:  B.E.: 0/0      QoS: 0/0
Intf    B.E. Quota:       2048  Kbps            QoS Quota:        0     Kbps
2/PPP   B.E. Max-q        0                     QoS Max-q         0
        B.E. curr-q       0                     QoS curr-q        0
        B.E. pkts/Kbytes sent:                  QoS pkts/Kbytes sent:
        in quota:           62/      6          in quota:            0/      0
        outside quota:       0/      0          outside quota:       0/      0
        B.E. pkts/bytes dropped: 0/0            QoS pkts/bytes dropped:  0/0
        DLC pkts/bytes dropped:  B.E.: 0/0      QoS: 0/0
Intf    B.E. Quota:       2032  Kbps            QoS Quota:        16    Kbps
3/FR    B.E. Max-q        1                     QoS Max-q         1
        B.E. curr-q       0                     QoS curr-q        0
        B.E. pkts/Kbytes sent:                  QoS pkts/Kbytes sent:
        in quota:        53160/   4920          in quota:       346596/  31886
        outside quota:       0/      0          outside quota:       0/      0
        B.E. pkts/bytes dropped: 0/0            QoS pkts/bytes dropped:  0/0
        DLC pkts/bytes dropped:  B.E.: 0/0      QoS: 0/0
Intf    B.E. Quota:       2048  Kbps            QoS Quota:        0     Kbps
4/PPP   B.E. Max-q        1                     QoS Max-q         1
        B.E. curr-q       0                     QoS curr-q        0
        B.E. pkts/Kbytes sent:                  QoS pkts/Kbytes sent:
        in quota:           66/      6          in quota:          109/     1
        outside quota:       0/      0          outside quota:       0/
        B.E. pkts/bytes dropped: 0/0            QoS pkts/bytes dropped:  0/0
        DLC pkts/bytes dropped:  B.E.: 0/0      QoS: 0/0

Max total queue length=1;  current total length=0
VCRM Console>clear
Flow-control Queues cleared at sys-clock 346786 Second:
-------
VCRM Console>
```

Monitoring VCRM (Talk 5)

Appendix. Remote AAA Attributes

This section contains the remote AAA Attributes use 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
3	L2TP	
TUNNEL_MEDIUM_TYPE		integer
1	IP	
TUNNEL_SERVER_EP		string
	ip address	

IBM Vendor Specific

NAS_TUNNEL_PASSWORD	101
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_CALLBACK_FLAGS	CBF
KWD_ENCRYPTION	ENC
KWD_HOSTNAME	HSN
KWD_SUBNETMASK	SNM
KWD_PRIVELGE	PRV

Values

PRIVILEGE:
ADMIN
OPER
MONITOR

CALLBACKFLAGS

REQ	required callback
ROAM	roaming callback

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
callback-dialstring

IBM Specific Attributes

encryption_key	16 hex characters
dial_out	TRUE FALSE ONLY

Accounting

task_id
start_time
stop_time
elasped_time
timezone
event
reason
bytes
bytes_in
bytes_out
paks
paks_in
paks_out
status
err_msg

List of Abbreviations

AARP AppleTalk Address Resolution Protocol

ABR area border router

ack acknowledgment

AIX Advanced Interactive Executive

AMA arbitrary MAC addressing

AMP active monitor present

ANSI American National Standards Institute

AP2 AppleTalk Phase 2

APPN Advanced Peer-to-Peer Networking

ARE all-routes explorer

ARI/FCI
address recognized indicator/frame copied indicator

ARP Address Resolution Protocol

AS autonomous system

ASBR autonomous system boundary router

ASCII American National Standard Code for Information Interchange

ASN.1 abstract syntax notation 1

ASRT adaptive source routing transparent

ASYNC
asynchronous

ATCP AppleTalk Control Protocol

ATP AppleTalk Transaction Protocol

AUI attachment unit interface

ayt are you there

BAN Boundary Access Node

BBCM Bridging Broadcast Manager

BECN backward explicit congestion notification

BGP Border Gateway Protocol

BNC bayonet Niell-Concelman

BNCP Bridging Network Control Protocol

BOOTP
BOOT protocol

BPDU bridge protocol data unit

bps bits per second

BR 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

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

GMT Greenwich Mean Time

GOSIP
Government Open Systems Interconnection Profile

GTE General Telephone Company

GWCON
Gateway Console

HDLC high-level data link control

HEX hexadecimal

HPR high-performance routing

HST TCP/IP host services

HTF host table format

IBD Integrated Boot Device

ICMP Internet Control Message Protocol

ICP Internet Control Protocol

ID identification

IDP Initial Domain Part

IDP Internet Datagram Protocol

IEEE Institute of Electrical and Electronics Engineers

Ifc# interface number

IGP interior gateway protocol

InARP Inverse Address Resolution Protocol

IP Internet Protocol

IPCP IP Control Protocol

IPPN IP Protocol Network

IPX Internetwork Packet Exchange

IPXCP IPX Control Protocol

ISDN integrated services digital network

ISO International Organization for Standardization

Kbps kilobits per second

LAN local area network

LAPB link access protocol-balanced

LAT local area transport

LCS LAN Channel Station

LCP Link Control Protocol

LED light-emitting diode

LF largest frame; line feed

LIS Logical IP subnet

LLC logical link control

LLC2 logical link control 2

LMI local management interface

LRM LAN reporting mechanism

LS link state

LSA link state advertisement

LSA Link Services Architecture

LSB least significant bit

LSI LAN shortcuts interface

LSreq link state request

LSrxl link state retransmission list

LU logical unit

MAC medium access control

Mb megabit

MB megabyte

Mbps megabits per second

MBps megabytes per second

MC multicast

MCF MAC filtering

MIB Management Information Base

MIB II Management Information Base II

MILNET
military network

MOS Micro Operating System

MOSDBG
Micro Operating System Debugging Tool

MOSPF
Open Shortest Path First with multicast extensions

MPC Multi-Path Channel

MPC+ High performance data transfer (HPDT) Multi-Path Channel

MSB most significant bit

MSDU MAC service data unit

MRU maximum receive unit

MTU maximum transmission unit

nak 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

OPCON
Operator Console

OSI open systems interconnection

OSICP
OSI Control Protocol

OSPF Open Shortest Path First

OUI organization unique identifier

PC personal computer

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

SNMP Simple Network Management Protocol

SNPA subnetwork point of attachment

SPF OSPF intra-area route

SPE1 OSPF external route type 1

SPE2 OSPF external route type 2

SPIA OSPF inter-area route type

SPID service profile ID

SPX Sequenced Packet Exchange

SQE signal quality error

SRAM static random access memory

SRB source routing bridge

SRF specifically routed frame

SRLY SDLC relay

SRT source routing transparent

SR-TB
source routing-transparent bridge

STA static

STB spanning tree bridge

STE spanning tree explorer

STP shielded twisted pair; spanning tree protocol

SVC switched virtual circuit

TB transparent bridge

TCN topology change notification

TCP Transmission Control Protocol

TCP/IP
Transmission Control Protocol/Internet Protocol

TEI terminal point identifier

TFTP Trivial File Transfer Protocol

TKR token ring

TMO timeout

TOS type of service

TSF transparent spanning frames

TTL time to live

TTY teletypewriter

TX transmit

UA unnumbered acknowledgment

UDP User Datagram Protocol

UI unnumbered information

UTP unshielded twisted pair

VCC Virtual Channel Connection

VINES VIrtual NEtworking System

VIR variable information rate

VL virtual link

VNI Virtual Network Interface

VR virtual route

WAN wide area network

WRS WAN restoral/reroute

X.25 packet-switched networks

X.251 X.25 physical layer

X.252 X.25 frame layer

X.253 X.25 packet layer

XID exchange identification

XNS Xerox Network Systems

XSUM checksum

ZIP AppleTalk Zone Information Protocol

ZIP2 AppleTalk Zone Information Protocol 2

ZIT Zone Information Table

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

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 acknowledge 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 (ASYNC). Pertaining to two or more processes that do not depend upon the occurrence of specific events such as common timing signals. (T)

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)

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)*.

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. (I) (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. (I)

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. (I)

data terminal equipment (DTE). That part of a data station that serves as a data source, data sink, or both. (I) (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.

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 *pacing*.

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.

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).

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

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 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.

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-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 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.

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. (I) (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) 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.

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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on recycled paper containing 10%
recovered post-consumer fiber.

SC30-3989-00

Spine information:

Access Integration Services AIS V3.2 Using Features SC30-3989-00