2216 Nways Multiaccess Connector

Introduction and Planning Guide

2216 Nways Multiaccess Connector

Introduction and Planning Guide

IBM

┌─ **Note** ───┐

Before using this information and the product it supports, be sure to read the general information under
Appendix E, "Notices" on page E-1.

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Second Edition (December 1997)

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About This Guide

This guide contains information to help you plan your network, to help define the hardware that you want to purchase, and the specifications for the hardware and software prerequisites to get your network installed.

This guide provides planning information for the IBM 2216 Nways Multiaccess Connector (hereafter referred to as the *IBM 2216*). It also provides information on the management of routing networks.

Who Should Read This Guide

The intended user is the person responsible for planning the setup and configuration of one or more IBM 2216s.

How to Proceed

You will determine which adapters and cables to order and the network configuration. Document all of the network information that will be required to install, connect, and configure the IBM 2216.

Take the following steps to plan and install your IBM 2216:

Note: If you are upgrading from Version 1 Release 1 of the Multiprotocol Access Services (the operating system software) to Version 2 Release 1 (or higher), see the upgrading/migrating information in the *Service and Maintenance Manual*.

Planning and Preparation

__ **1** Get familiar with the capabilities of the IBM 2216. (See Chapter 1, "Introduction to the IBM 2216" on page 1-1.)

__ **2** Determine which adapters and cables you will need. Chapter 2, "Functions of the IBM 2216," has details about available options. Design your network and place your order for your IBM 2216s and cables. (Cables are described in Appendix B, "Cable Pin Assignments" on page B-1.)

__ **3** If necessary, obtain and install the required common carrier equipment and services, including ATM.

__ **4** Obtain and install the required LAN equipment and services.

__ **5** Order and install any required cables not included with the IBM 2216, such as ATM multimode and single-mode fiber cables that you will need to set up your network.

__ **6** Obtain and install the hardware and software required to run the Configuration Program, as described in "Hardware and Software Requirements for the Configuration Program" on page 3-2.

__ **7** Prepare Quick Configuration and Initial Configuration worksheets. These worksheets are in "Quick Configuration Worksheet" on page A-4.

__ **8** Prepare your site physically, ensuring that you meet the necessary power and environmental requirements. See "Preparing the Machine Area" on page 3-1.

Installation and Initial Configuration

__ **1** Install the IBM 2216 using the *Installation and Initial Configuration Guide* provided with the product. (Alternatively, installation by IBM service personnel is available. Contact your IBM representative for additional information.)

__ **2** Connect a terminal to the serial port or PCMCIA modem to enable you to do the initial configuration steps.

__ **3** Access the IBM 2216 firmware to enable you to do initial configuration.

__ **4** Create network interfaces for each port of each adapter that is installed in the 2216 using the **Add Device** command.

__ **5** Run the "Quick Configuration" program to perform the initial configuration and activate your IBM 2216.

Configuration

__ **1** Perform final configuration. See *Configuration Program User's Guide* and *Software User's Guide*.

Planning and Installation

Introduction
and
Planning
Guide

GA27-4105

Installation
and
Initial
Configuration
Guide

GA27-4106

Hardware
Configuration
Quick
Reference Card
GX27-3988

Configuration

Configuration
Program
User's
Guide

GC30-3830

Configuration
Program
READ.ME
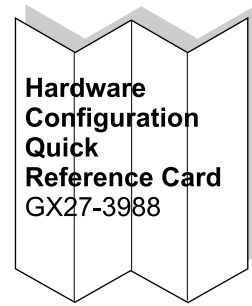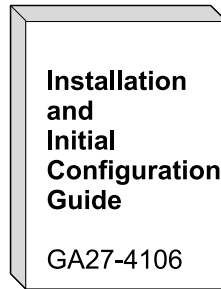
Configuration
Help
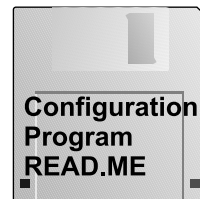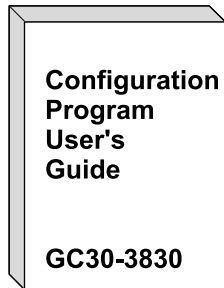
Diagnostics/ Maintenance

Service
and
Maintenance
Manual

SY27-0350
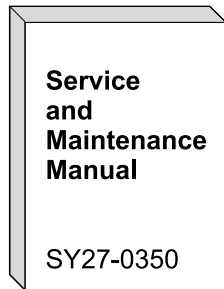
Operations and Network Administration

Software
User's
Guide

SC30-3886

Protocol
Configuration
and
Monitoring
Reference

SC30-3884
SC30-3885

Event
Logging
System
Messages
Guide

SC30-3682
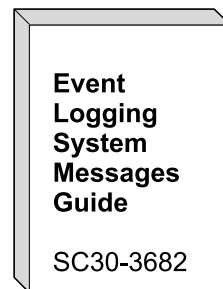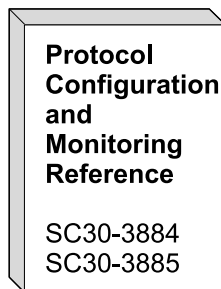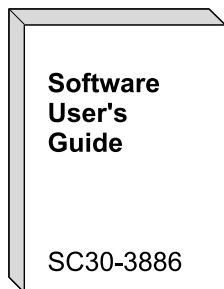
2216 Library Overview

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

Table 0-1. Hardcopy Publications that Are Shipped with the 2216

These documents are shipped in hardcopy and are also contained on the 2216 CD-ROM, SK2T-0405.

Planning

GA27-4105   *2216 Nways Multiaccess Connector Introduction and Planning Guide*

             This book explains how to prepare for installation, select the hardware that you want to purchase, and specifications for the hardware and software for your network. It also provides information on the management of routing networks.

Installation

GA27-4106   *2216 Nways Multiaccess Connector Installation and Initial Configuration Guide*

             This booklet explains how to install the IBM 2216 and verify its installation.

GX27-3988   *2216 Nways Multiaccess Connector Hardware Configuration Quick Reference*

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

Diagnostics and Maintenance

SY27-0350   *2216 Nways Multiaccess Connector Service and Maintenance Manual*

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

Safety

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

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

Table 0-2. Softcopy Publications that Are Shipped on the CD-ROM

Operations and Network Management

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

SC30-3886   *Nways Multiprotocol Access Services Software User's Guide*

This book explains how to:

- Configure, monitor, and use the Nways Multiprotocol Access Services software.

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

SC30-3884   *Nways Multiprotocol Access Services Protocol Configuration and Monitoring Reference, Volume 1*

SC30-3885   *Nways Multiprotocol Access Services Protocol Configuration and Monitoring Reference, Volume 2*

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

They include information about each of the protocols that the device supports.

SC30-3682   *Nways 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*

This book discusses how to use the Nways Multiprotocol Access Services Configuration Program.

Visit our Web Sites

This IBM web page provides product information:

```
http://www.networking.ibm.com/216/216prod.html
```

Information, Updates, and Corrections

This page provides information on engineering changes, clarifications, and fixes that were implemented after the books were printed:

`http://www.networking.ibm.com/216/216lib.html#relnts`

Summary of Changes

The changes to the IBM 2216 library and product since the first edition of the product information are indicated by a vertical line (|) to the left of the change, and consist of:

- Library Improvements

  - Content changes to the planning guide, the installation guide, and the maintenance manual (along with changes to the book titles)

  - Clarifications and corrections

- Product enhancements :

  - Hardware Updates

    - These adapters / Line Interface Couplers (LICs):

      - LIC 286, FDDI
      - LIC 289, HSSI
      - LIC 288, 10/100 Mbps Ethernet
      - LIC 287, ESCON Channel (from Release 1.1)
      - LIC 294 high-performance 155-Mbps ATM multimode fiber (MMF)
      - LIC 295 high-performance 155-Mbps ATM single-mode fiber (SMF)

    - System card (200-Mhz) with 64-MB base memory (and additional 64-MB memory option)

  - Software Updates

    - Protocol Enhancements:
      - IP
      - IPX
      - Bridging
      - APPN
      - Appletalk
      - DLSw
    - Infrastructure Enhancements
    - Serviceability
    - Server Enhancements
    - Network Management
    - Connectivity Enhancements
      - PPP
      - Frame Relay
      - X.25
      - LAN
      - WAN
      - ISDN
      - Channel (ESCON)
    - ATM Enhancements
    - ESCON Channel Adapter Enhancements:
      - Support for IP over MPC+ to TCP/IP in the Host.
      - Support for IP over MPC+ to HPDT UDP in the Host.

Chapter 1. Introduction to the IBM 2216

The IBM 2216 Nways Multiaccess Connector provides an answer to the problem of interconnecting networks using multiple protocols, devices, and lines. It gives the networking customer a method of routing and bridging across LANs and WANs, supporting a variety of network protocols across various types of media.
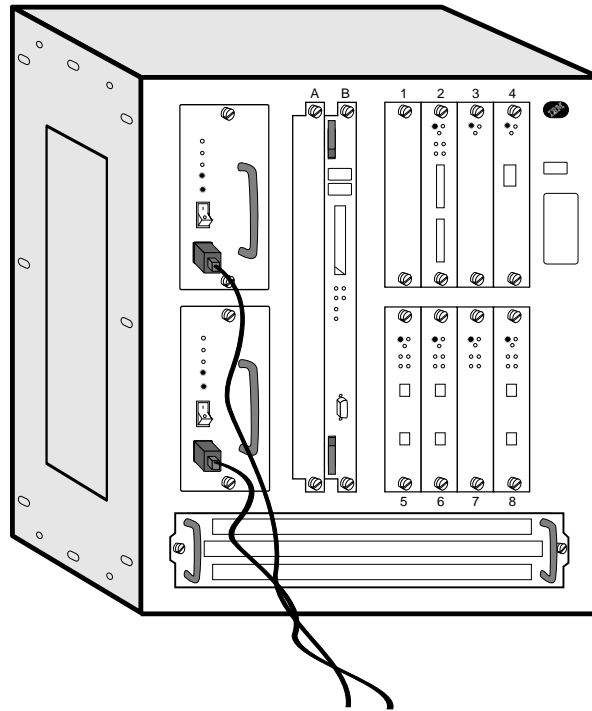
The IBM 2216 can play a vital role by interconnecting sites to support network computing. It enables you to:

- Improve the capabilities of your networks to provide information to field organizations, product development teams, customer service personnel, and your customers and suppliers

- Exploit intranets to improve access to internal information

- Use the Internet to transact business electronically with your customers and suppliers

- Maximize the potential of your networks

- High-performance access to SNA and IP S/390 host applications

- Optimize your networks by consolidating branch office traffic, Frame Relay connections from multiple FRADs, or SNA and APPN traffic from remote SNA controllers

- Consolidate your SNA and IP networks with a single network that supports both efficiently

- Acquire a platform with growth capabilities that eases the transition to future network requirements

The 2216 provides wide area network access, network optimization, device attachment, and concentration. It fits naturally between IBM's workgroup and campus routers and switches and its high-capacity broadband switches as an exciting new network computing building block.

IBM 2216 Highlights

The IBM 2216 offers the following advantages over the equipment you may be currently using:

- Superior scalability
- Broad range of network connectivity choices
- Adaptability to a wide range of network configurations
- High system availability
- Maximum network availability
- Easy configuration, installation, and maintenance
- Superior serviceability

Additional Technical Details

Superior Scalability: The 2216 can support up to 64 attachments for device access or network consolidation. The 2216 has eight adapter slots with up to eight interfaces per adapter, giving it more than five times the WAN capacity of the largest 2210 Nways router. This makes it an excellent choice for data center access or regional concentration of remote branch offices.

Adaptability to a Wide Range of Network Configurations: The 2216 uses the same routing, bridging, and SNA capabilities proven in the 2210 Nways router. These functions, called *Multiprotocol Access Services*, include standards-based, interoperable support for routing and bridging, with security and rerouting, on leased and switched networks.

Multiprotocol Access Services includes the following functions:

- Advanced SNA data transport, with APPN network node (NN), high-performance routing (HPR), dependent LU requestor (DLUR), data link switching (DLSw, or RFC 1795, including NetBIOS support), and support for LAN Network Manager protocols

- All common routing protocols including IP, IPX, AppleTalk 2, Banyan VINES, DECnet IV, and DECnet V/OSI

  IP routing includes ICMP, TCP, UDP, RIP, OSPF V2, BGP-4, static routes, Multicast Extensions to OSPF (MOSPF), ARP, InARP and IP Access Controls.

- All common bridging techniques, including transparent, source-route, source-route transparent, source-route to transparent translational bridging, and IP bridging tunnels

- The two primary forms of handling data traffic over ATM links; ATM Forum-compliant LAN Emulation (LANE) and Classical IP

- V.25 bis and ISDN PRI switched network access with worldwide ISDN software options, WAN restore, and dial-on-demand

- Frame relay (RFC 1490 including boundary access node [BAN] support), PPP, X.25 DTE, both primary and secondary SDLC

  – WAN reroute is supported for recovery from Frame Relay, PPP or X.25 link failures

– Bandwidth reservation to assign traffic priority is supported over Frame Relay and PPP

Broad Range of Network Connectivity Choices: You can choose from among the following attachments:

- 2-port Token-Ring
- 2-port Ethernet
- 1-port 10/100-Mbps Ethernet
- 8-port EIA-232E/V.24
- 6-port V.35 or V.36
- 8-port X.21
- 1-port ISDN PRI for E1 (30 B+D)
- 1-port ISDN PRI for T1/J1 (23 B+D)
- 1-port 155-Mbps ATM single-mode fiber
- 1-port 155-Mbps ATM multimode fiber
- 1-port ESCON Channel
- 1-port HSSI
- 1-port FDDI

See "Options" on page 2-3 for more information about these adapters. Adapters can be positioned in any slot (with the exceptions as described in "Slots and Adapters" on page C-2).

High System Availability: The 2216 has a number of design features that maximize its availability and the availability of the networks to which it connects.

The hardware supports a high degree of redundancy and non-disruptive operation with:

- Optional dual power supplies that share the 2216 power load. Each has its own power cord for connection to independent power sources. If a power supply fails, the 2216 continues with the operational supply.

- Individually powered adapters that can be inserted or removed while the 2216 is operational. Failed adapters can be replaced without taking down the system or rebooting the software. Replaced adapters assume the configuration of the adapter they replace.

- System cooling with multiple fans that can maintain safe operating temperatures if a fan fails.

- Extensive environmental monitoring that tracks system operation and allows operators to correct potentially critical situations before they cause outages.

Maximum Network Availability: The 2216 software increases system and network availability with:

- Dial backup to bypass failed connections using either V.25 bis or an ISDN Primary Rate Interface

- Routing around failed Frame Relay, PPP, or X.25 links

Easy Configuration, Installation and Maintenance: The 2216 takes on average less than two hours to install. Initial configuration to connect the 2216 to a network is done using either a local ASCII terminal or an ASCII terminal connected via a modem. Subsequent configuration can be done using a graphical configuration program running on AIX, OS/2, or Windows.

Once configured, the 2216 can be managed by an SNMP manager. IBM provides comprehensive, easy-to-use graphical administration, management, problem analysis, and reporting software as a component of its Nways Managers which are available for AIX and Windows NT.

Superior Serviceability: Adapters, power supplies, cooling subassembly, and the processor card are accessible from the front panel, allowing replacement in seconds without having to remove the 2216 from a rack or remove its covers. The 2216 maintains its configuration and operating history in nonvolatile storage, speeding problem identification and diagnostics. An integrated modem is available in most countries for remote diagnostics. These features are combined with globally available, on-site support and field replacement of failed components 24 hours a day, 7 days a week.

Benefits

The IBM 2216:

- Provides a broad range of LAN, WAN, and ATM network connection options, allowing flexible, money-saving network consolidation at regional concentration points or data centers

- Provides a high-performance access to IP and SNA S/390 host applications.

- Offers the functions of a multiprotocol router, Frame Relay Access Device (FRAD) and SNA remote controller, in a single product with high port density and the ability to connect and concentrate diverse networks, reducing acquisition and operating costs

- Delivers compatibility with IBM 2210 and the IBM campus MSS solutions

- Provides a cost-effective, scalable solution, with eight adapter slots that can expand to accommodate new technologies as needed, when needed

- Uses Multiaccess Services software, with rich routing and bridging functions proven in the 2210 Nways router, maximizing interoperability and commonality and minimizing the need for operator training

- Provides an excellent solution for SNA remote concentration, with multiple SNA options including Frame Relay BAN, DLSw, and APPN HPR

- Offers flexible dial backup to recover from failures and dial-on-demand to minimize network line costs

- Minimizes the possibility of failure and the time to recover from failure with highly redundant hardware, fast reboot for rapid reconfiguration, and excellent serviceability

- Minimizes total cost of operation with easy-to-use tools for rapid installation and configuration and integrated, remote, graphical management tools

Additional Information

Prices and part numbers for some IBM 2216 components can be obtained from our 2216 web site (http://www.networking.ibm.com/216/216fact.html).

Chapter 2. Functions of the IBM 2216

The software that supports the IBM 2216 is Nways Multiprotocol Access Services, a licensed program (number 5765-C90) with the following components:

- The code that provides the routing, bridging, data link switching, and SNMP agent functions for the IBM 2216. This code also includes a monitoring system that allows you to perform change management, network management, problem determination, and configuration. The base code is installed at the factory on the IBM 2216.

- The Configuration Program, which offers a graphical user interface that allows you to configure the IBM 2216 from a stand-alone workstation. See "Hardware and Software Requirements for the Configuration Program" on page 3-2.

Networks Supported

The LANs supported by the IBM 2216 are:

- Token-ring (IEEE 802.5) with STP or UTP connection
- Ethernet IEEE 802.3 with 10BASE2 (coax) or 10BASE-T (RJ-45) connection
- Ethernet 802.3u with RJ-45 connection
- FDDI (multimode fiber)

The other interfaces supported by the IBM 2216 are:

- EIA-232E/V.24
- V.35
- V.36
- X.21
- ISDN—Primary (T1)
- ISDN—Primary (E1)
- ATM 155-Mbps multimode fiber
- ATM 155-Mbps single-mode fiber
- HSSI
- ESCON

Protocols Supported

Table 2-1 shows the protocols supported by each IBM 2216 interface. For the ESCON interface, see "2216 ESCON Functional Support" on page 5-4.

Table   2-1. 2216 Supported Routing and Bridging Protocols

	WANs						LANs			
					Serial and ISDN		Token-Ring	Ethernet	ATM	FDDI
Framing Methods	PPP	FR	X.25	SDLC	Dial on Demand	Dial Backup				
Protocols										
Banyan VINES	yes	yes	yes	no	yes	yes	yes	yes	yes[5]	yes
TCP/IP	yes	yes	yes	no	yes	yes	yes	yes	yes	yes
DECnet IV	yes	yes	yes[3]	no	yes	yes	yes	yes	yes[5.]	yes
DECnet V/OSI	yes	yes	no[4]	no	yes	yes	yes	yes	yes[5]	yes
BGP	yes	yes	yes	no	yes	yes	yes	yes	yes	yes
NetBIOS	yes	yes	yes	no	yes	yes	yes	yes	yes[5]	yes
LNM	yes	yes	yes	no	yes	yes	yes	no	yes[5]	no
IPX	yes	yes	yes	no	yes	yes	yes	yes	yes[2]	yes
AppleTalk	yes	yes	yes[1]	no	yes	yes	yes	yes	yes[5]	yes
SNA	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
SRB	yes	yes	yes	no	yes	yes	yes	no	yes[5]	no
TB	yes	yes	yes	no	yes	yes	no	yes	yes[5]	yes
SRT	yes	yes	yes	no	yes	yes	yes	yes	yes[5]	no
SR/TB	yes	yes	yes	no	yes	yes	yes	yes	yes[5]	no

Notes:

1. X.25 routing is accomplished using IP Bridging Tunnel over X.25.
2. IPX is supported using Token-Ring and Ethernet LAN emulation. In addition, IPX is supported between routers that support RFC 1483 encapsulation.
3. DECnet IV is supported on X.25 only in the IBM modes of operation. The DEC compatibility modes of operation do not work even though you can configure them.
4. DECnet V/OSI is not supported on X.25.
5. Supported through LAN Emulation or bridging only

Features Supported

The base IBM 2216 consists of:

- A 19-inch cabinet, which can either be placed on a table top or installed in a rack

- One power supply (with redundant power option)

- A cooling fan tray assembly

- A system backplane

- A system card containing either:

    - A 604E 133-MHz PowerPC microprocessor
    - 64-MB DRAM
    - A 512-KB L2 cache
    - A 1.08-GB IDE hard drive

  OR

    - A 604E 200-MHz PowerPC microprocessor
    - 64-MB DRAM (can be upgraded to 128-MB)
    - A 512-KB L2 cache
    - A 1.6-GB hard drive

- Eight adapter slots
- A PCMCIA modem (where available):
  - A 28.8-Kbps data modem with integrated DAA for the U.S. and Canada
  - A 28.8-Kbps data modem with programmable DAA for countries other than the U.S. and Canada

Options

Note: Adapters can be inserted and removed while the IBM 2216 is operational. Failed adapters can be replaced without taking the system down or rebooting the software. The replaced adapter assumes the configuration of the failed adapter.

New adapters can be added without powering the system down and can be acti-vated at a convenient time. (The "Configuring Spare Interfaces" chapter in the *Multiprotocol Access Services Software User's Guide* has details.)

The following adapters are available for the IBM 2216. Each adapter is followed by its feature code.

Table 2-2. IBM 2216 Adapters and Feature Codes

Adapter	Feature Code (FC)
2-port Token-Ring	2280
2-port Ethernet	2281
8-port EIA-232E/V24	2282
1-port ISDN-PRI (T1/J1 interface)	2283
1-port ATM 155-Mbps MMF	2284
1-port FDDI	2286
1-port ESCON Channel	2287
1-port 10/100-Mbps Ethernet	2288
1-port HSSI	2289
6-port V.35/V.36	2290
8-port X.21	2291
1-port ISDN-PRI (E1 interface)	2292
1-port ATM 155-Mbps SMF	2293
1-port high-performance ATM 155-Mbps MMF	2294
1-port high-performance ATM 155-Mbps SMF	2295

2-port Token-Ring (FC 2280)
Provides for two attachments to Token-Ring LANs. This adapter can continually process frames of data to and from system memory and the Token Ring at a speed of either 4 Mbps or 16 Mbps. It supports the use of either shielded twisted-pair and unshielded twisted-pair cable through a single connector. Cable 2713 is available for this adapter.

2-port Ethernet (FC 2281)
Provides for two attachments to Ethernet LANs. It supports the use of either 10BASE-T cable or 10BASE2 cable. Cable 2713 is available for this adapter.

8-port EIA-232E/V.24 Adapter (FC 2282)

Provides eight attachments to EIA-232E/V.24 WANs. Each attachment provides:

- Support for receiving clocking (modem-attached) at a line speed from 2.4 Kbps to 64 Kbps

- Support for providing clock (directly attached) from 9.6 Kbps to 64 Kbps

- Software selectable to receive clock (modem-attached) or provide clock (directly attached) with the appropriate cable

- A 100-pin D-shell female connector

- Support for cables FC 2701, FC 2705, and FC 2706

1-port ISDN PRI (T1/J1) Adapter (FC 2283)

Provides one attachment to an ISDN Primary Rate service at T1/J1 speed.

Note: With the MAS Version 2 Release 2 PTF, this can also be used for channelized T1/J1.

This attachment provides:

- Support for T1/J1 line speed of 1.544 Mbps
- Twenty-three 64-Kbps B-channels for data and one 64-Kbps D-channel for signaling
- Selectable framing to D4 (SF), D5 (ESF), or SLC-96R formats
- Detection and generation of yellow and blue alarms
- Facility Data Link (FDL) support
- Generation of DSX-1 and CSU line build outs
- Generation and detection of CSU loop codes
- Line error counters for BPV, CV, CRC6, and framing-bit errors
- Monitoring and enforcing of ANSI ones density requirement
- Extraction and insertion of robbed-bit signaling
- B8ZI and AMI line coding
- DB-26 (26-pin D-shell) female connector
- Support for cables FC 2714 and FC 2716

1-port ATM 155-Mbps Multimode Fiber Adapter (FC 2284 and 2294)

Both adapters provide identical function; however, FC 2294 has higher throughput.

Provides one attachment to an ATM switch over a multimode fiber-optic cable. Each attachment provides:

- 8 MB of packet memory and 2 MB of control memory for high-performance support

- A specialized ATM support chip to perform the segmentation and reassembly (SAR) function for ATM Adaptation Layer 5 (AAL-5)

- SONET OC3c framing

- Nominal operating wavelength of 1300 nm using LED-based technology

- Support for a 62.5/125μm multimode fiber

- A multimode duplex SC connector

Note: A cable is not provided with the IBM 2216 for this adapter. The following IBM fiber optic cables can be used with this adapter: the 4-meter cable #19G4864 and the 6-meter cable #19G4865.

1-port FDDI (FC 2286)

Provides one attachment to an FDDI dual attaching system (DAS) connection. This attachment provides:

- One FDDI DAS port on the card

- 4-KB entry hardware Transparent Bridging (to support bridging at the media speed)

- Networking support for standard: "Fiber Distributed Data Interface (FDDI)"

    - Part 1: Token Ring Physical Layer Protocol ISO 9314-1: 1989

    - Part 2: Token Ring Media Access Control (MAC) ISO 9314-2: 1989

    - Part 3: Token Ring Physical Layer Medium Dependent (PMD) ISO/IEC 9314-3: 1990

- External cabling:

    - Fiber cabling standard: ANSI X3.T9.5

- FDDI DAS port media connectors: Multi-mode fiber SC

- FDDI DAS Optical Bypass Connector

Note: A cable is not provided with the IBM 2216 for this adapter. The following IBM fiber optic cables can be used with this adapter: the 4-meter cable #19G4864 and the 6-meter cable #19G4865.

1-Port ESCON Channel Adapter (FC 2287)

Provides the IBM 2216 with access to SNA and TCP/IP host applications from LANs, WANs, and ATM over a duplex-to-duplex multimode fiber-optic cable. The adapter features:

- High-performance IP and SNA host-application access, featuring Multi-Path Channel+ (MPC+) support for high-throughput APPN high-performance routing (HPR) to VTAM 4.4 SNA applications.

    TCP/IP and High-Performance Data Transfer (HPDT) for User Datagram Protocol (UDP) can also use the MPC+ support. (The TCP/IP and UDP+ over MPC is available in Version 2 Release 2 of MAS.)

- APPN intermediate session routing (ISR) to VTAM 3.4 (or higher) SNA applications.

- APPN HPR support for VTAM 4.4 SNA applications

- APPN and IP routing over any other 2216 interface.

- Dependent LU Requestor (DLUR) in APPN to provide connectivity between dependent downstream SNA devices and VTAM SNA applications.

- Boundary access node (BAN) support in APPN to provide connectivity between downstream BAN Frame Relay Access Devices (FRADs) and VTAM SNA applications.

- IP route selection based on static, RIP, OSPF, and BGP-4 routes and filtering of IP frames coming from or destined for the channel.

- Data link switching (DLSw) support for VTAM 3.4 (or higher) SNA applications.

  DLSw allows for local (single 2216) conversion from SDLC and LANs to the channel and remote (via DLSw partners) connectivity to SNA devices on SDLC, LANs, and ATM forum-compliant LAN emulation (LANE).

- ESCON channel connectivity for Token Ring, Ethernet, FDDI and ATM LAN emulation.

- Support for up to four ESCON adapters.

- Support for up to 32 ESCON logical addresses (subchannels) per adapter for access to up to 32 hosts for Link Services Architecture (LSA) or 16 hosts for Logical Channel Station (LCS) or 16 hosts for MPC+ (assuming these types are not mixed on the adapter) when used with an IBM 9032 or 9033 ESCON Director or access to up to 15 logical host images in EMIF-capable processors operating in a logically partitioned (LPAR) mode.

1-port 10/100-Mbps Ethernet (FC 2288)

Provides one port for 10/100 Mbps Ethernet connections using an RJ-45 connector. This attachment provides:

- 4-KB entry hardware Transparent Bridging (to support bridging at the media speed)

- IEEE 802.3 10-Mbps Ethernet

- IEEE 802.3u 100-Mbps Ethernet

Cable 2713 is available for this adapter.

1-port High-Speed Serial Interface HSSI Adapter (FC 2289)

Provides one port for HSSI connection through a 5-meter (about 16.4 ft) STP cable (that is included with the adapter). The cable uses 2-row 50-pin SCSI connectors. Two types of HSSI Cables can be used with the HSSI adapter: One cable for DTE-to-DCE attachment where the HSSI adapter is the DTE, and one cable for back-to-back direct connection of one HSSI adapter to another HSSI adapter. (The second cable is called a null-modem or cross-over cable).

The HSSI attachment provides:

- Support for network standards:

  - ANSI/EIA/TIA 613-1993, "High-speed Serial Interface for Data Terminal equipment and Data Circuit-Terminating Equipment"

  - ANSI/EIA/TIA 612-1993, "Electrical Characteristics for an Interface at Data Signaling Rates up to 52 Mbps"

- DTE interface for applications

- DCE interface for test

- Support for STP cable type

- Receive clocking at line speeds of 1.544 Mbps (T1 speed) to 52 Mbps

- Clocking at the following speeds:

  - 44.736 Mbps
  - 22.368 Mbps

6-Port V.35/V.36 Adapter (FC 2290)

Provides six attachments to ITU-T V.35 or V.36 WANs. Each attachment provides:

- Support for receiving clocking (modem-attached) at a line speed from 2.4 Kbps to 2.048 Mbps

- Support for providing clock (directly attached) from 9.6 Kbps to 460.8 Kbps as well as 1.544 Mbps and 2.048 Mbps

- Software selectable to receive clock (modem-attached) or provide clock (directly attached) with the appropriate cable

- A 100-pin D-shell female connector

- Support for cables FC 2702, FC 2703, FC 2707, FC 2708, FC 2709 FC 2710, and FC 2799

  With the V.35/V.36 you can use the following combination of cables:

  - FC 2702 with FC 2707, FC 2708, and FC 2799 (for V.35)
  - FC 2703 with FC 2709 and FC 2710 (for V.36)

Note: Cabling to mix V.35 and V.36 interfaces on adapter FC 2290 is not provided.

8-Port X.21 Adapter (FC 2291)

Provides eight attachments to ITU-T X.21 WANs. Each attachment provides:

- Support for receiving clocking (modem-attached) at a line speed from 2.4 Kbps to 2.048 Mbps

- Support for providing clock (directly attached) from 9.6 Kbps to 460.8 Kbps as well as 1.544 Mbps and 2.048 Mbps

- Software selectable to receive clock (modem-attached) or provide clock (directly attached) with the appropriate cable

- A 100-pin D-shell female connector

- Support for cables FC 2704, FC 2711, and FC 2712

1-port ISDN PRI (E1) Adapter (FC 2292)

Note: With the MAS Version 2 Release 2 PTF, this can also be used for channelized E1.

Provides one attachment to an ISDN Primary Rate service at E1 speed. This attachment provides:

- Support for E1 line speed of 2.048 Mbps
- Thirty 64-Kbps B-channels for data and one 64-Kbps D-channel for signaling
- Selectable framing to FAS, CAS, and CRC4 formats
- Detection and generation of remote and AIS alarms
- Full access to both Si and Sa bits
- Generation of line build outs for a 120-ohm line
- Three separate loopbacks for testing
- Line error counters for bipolar and code violations, CRC4 code word errors, FAS errors, and E-bits
- Extraction and insertion of CAS signaling
- B8ZI and AMI line coding
- DB-26 (26-pin D-shell) female connector
- Support for cable FC 2715.

1-port ATM 155-Mbps Single-Mode Fiber Adapter (FC 2293 and 2295)

Both adapters provide identical function; however, FC 2295 has higher throughput.

Provides one attachment to an ATM switch over a single-mode fiber-optic cable. Each attachment provides:

- 8 MB of packet memory and 2 MB of control memory for high-performance support

- A specialized ATM support chip to perform the segmentation and reassembly (SAR) function for ATM Adaptation Layer 5 (AAL-5)

- SONET OC3c framing

- Nominal operating wavelength of 1310 nm using laser-based technology

- Support for a 9/125μm single-mode fiber

- Transceiver support for a maximum cable length of 20 km (12.4 miles)

- A single-mode polarized duplex SC connector

Note: A cable is not provided with the IBM 2216 for this adapter. The following IBM fiber optic cables can be used with this adapter: the 4-meter cable #19G4864 and the 6-meter cable #19G4865.

Cables

The following adapter cables are available for use with the IBM 2216.

- EIA-232E/V.24 Fanout Cable (FC 2701)

  This fanout cable provides eight connections (25-pin D-shell male) each of which is 1.8 meters (5.2 feet) in length. Each connection is suitable for connection to a EIA-232/V.24 modem.

  Cables 2705 and 2706 are available to complement this cable. FC 2705 attaches to the FC 2701 and extends the cable length an additional 3 meters (10 feet) for attachment to a modem. FC 2706 attaches to FC 2701 and provides clocking to allow devices to be directly attached to the IBM 2216 without having to use a modem. It is 3 meters (10 feet) in length and provides a female 25-pin D-shell connector.

- V.35 Fanout Cable (FC 2702)

  This fanout cable provides a 1.2-meter (4-foot) cable to a distribution box containing six 25-pin D-shell male connectors.

  Cables 2707 and 2708 are available to complement this cable. FC 2707 provides a 3-meter (10-foot) extension cable with a 34-pin male block connector for attachment to a modem. FC 2708 provides a 2-meter (6.6-foot) cable with a 34-pin female block connector for direct-device attachment.

- V.36 Fanout Cable (FC 2703)

  This fanout cable provides six connections (37-pin D-shell male) each of which is 3 meters (9.8 feet) in length. Each connection is suitable for connection to a V.36 modem.

  Cables 2709 and 2710 are available to complement this cable. FC 2709 provides a 3-meter (10-foot) extension cable with a 37-pin male D-shell connector

for attachment to a modem. FC 2710 provides a 3-meter (10-foot) cable with a 37-pin female D-shell connector for direct-device attachment.

- X.21 Fanout Cable (FC 2704)

  This fanout cable provides eight connections (15-pin D-shell male) each of which is 1.8 meters (5.9 feet) in length. Each connection is suitable for connection to an X.21 modem.

  Cables 2711 and 2712 are available to complement this cable. FC 2711 provides a 3-meter (10-foot) extension cable with a 15-pin D-shell male connector for attachment to a modem. FC 2712 provides a 3-meter (10-foot) cable with a 15-pin D-shell female connector for direct-device attachment.

- EIA-232E/V.24 Serial Interface Cable (FC 2705)

  This cable provides a 3-meter (10-foot) extension cable with a 25-pin D-shell male connector for attachment to a modem.

- EIA-232E/V.24 Direct Attach Cable (FC 2706)

  This cable provides a 3-meter (10-foot) cable with a 25-pin D-shell female connector for direct-device attachment.

- V.35 Serial Interface Cable (FC 2707)

  This cable provides a 3-meter (10-foot) extension cable with a 34-pin male block connector for attachment to a modem.

- V.35 Direct Attach Cable (FC 2708)

  This cable provides a 2-meter (6.6-foot) cable with a 34-pin female block connector for direct-device attachment.

- V.36 Serial Interface Cable (FC 2709)

  This cable provides a 3-meter (10-foot) extension cable with a 37-pin male D-shell connector for attachment to a modem.

- V.36 Direct Attach Cable (FC 2710)

  This cable provides a 3-meter (10-foot) cable with a 37-pin female D-shell connector for direct-device attachment.

- X.21 Serial Interface Cable (FC 2711)

  This cable provides a 3-meter (10-foot) extension cable with a 15-pin D-shell male connector for attachment to a modem.

- X.21 Direct Attach Cable (FC 2712)

  This cable provides a 3-meter (10-foot) cable with a 15-pin D-shell female connector for direct-device attachment.

- Multipurpose RJ-45 Adapter Cable (FC 2713)

  This cable provides a 7.6-meter (25-foot) Category 5 cable with an RJ-45 connector for attachment to token-ring hubs or switches or Ethernet 10BASE-T hubs or switches.

- RJ-48 T1 ISDN PRI Cable (FC 2714)

  This cable provides a 15-meter cable with an RJ-48 connector for attachment to T1 ISDN PRI switches.

  Attention: The ISDN PRI T1 communications line access point should be correctly installed by qualified service personnel. If connection is made to the

2216 T1 cable's RJ-48C connector grounding pins at the communication line access point, this conductor should not be routed externally to the building in which the 2216 is installed.

- ISDN PRI (E1) Cable (FC 2715)

  This cable provides a 30-meter (100-foot) cable with "flying leads" suitable for wiring to E1 ISDN PRI switches.

- RJ-48 J1 ISDN PRI Cable (FC 2716)

  This cable provides a 15-meter (50-foot) cable with a RJ-48 connector for attachment to J1 ISDN PRI switches.

- Attachment Cable for V.35 DCE (FC 2799) - for France

  This cable provides a 30-cm (1-foot) cable that adapts the standard V.35 34-pin male block connector to the connector required for attachment to V.35 modems in France.

- The cable for each IBM 2216 ESCON Channel Adapter must be ordered separately.

  - In the USA , Canada, and Latin America, order cable group #3797 or PN 14F3797 in the following standard lengths:

    4 m (12 ft)
    7 m (20 ft)
    13 m (40 ft)
    22 m (70 ft)
    31 m (100 ft)
    46 m (150 ft)
    61 m (200 ft)
    77 m (250 ft)
    92 m (300 ft)
    107 m (350 ft)
    122 m (400 ft)

  - In EMEA or AP, see "ESCON Cabling Information" in publication number GC22-7064 to order the cables.

  For additional information on planning for IBM 2216 ESCON Channel Adapter cable installations, refer to *Fiber Optic Link Planning*, GA23-0367.

The following cables are not provided as options for the IBM 2216 and must be obtained by the customer, as required:

- Token-Ring STP Network Adapter Cable
- Ethernet 10BASE2 Cable
- ATM multimode fiber adapter cable
- ATM single-mode fiber adapter cable
- FDDI

See Appendix B, "Cable Pin Assignments" on page B-1.

Chapter 3. Physical Planning and Prerequisites

Placement Options

The IBM 2216 can be placed on a table top or in a rack.

Table Top

If the IBM 2216 is placed on a table top, the table must meet the requirements for service and operating clearances listed under "Service Clearances" on page 3-4.

Rack

If you choose rack-mounting, you must provide the rack; it is not provided with the IBM 2216.

You can use any EIA standard 19-inch rack. The attachment holes along each side of a rack are usually divided into units of measure called *EIA units*. Each EIA unit equals 44.5 mm (1.75 in.).

The rack can be open or closed. However, if you choose a closed rack, you must make sure that enough air flows through the IBM 2216. Covers on the front of the rack that would not let air reach the IBM 2216 must be removed or modified to let air pass. Similarly, unvented rear rack covers that would not let air exit the IBM 2216 or that would cause back pressure to build up from several machines must not be used.

Preparing the Machine Area

To prepare the area where the machine will be installed, you need to consider the following requirements:

- The physical dimensions of the machine

- The area that must be left free around the machine for easy access to the cables, connectors, and parts to be replaced.

- Environmental constraints

Access to the Unit

All cables are attached at the front of the unit. In addition, all LEDs are on the front and all features are installed from the front. This simplifies setup and maintenance of the unit and minimizes the service area required to access it.

Hardware Requirements

You must provide the following hardware to operate the IBM 2216:

- Any cables that are not provided with the IBM 2216. See Appendix B, "Cable Pin Assignments" for a list of IBM cable feature numbers.

- A modem for the IBM 2216. In most cases, this is a PCMCIA modem that is provided with the initial IBM 2216 order. For some countries, the modem is not available. Your IBM representative can tell you whether you will receive the modem. If the modem is not shipped with your IBM 2216, you will have to supply a modem that connects to the serial port. It must support the AT command set and one of the following protocols:

  - ITU-T V.32 at 9.6 Kbps
  - ITU-T V.32 bis at 14.4 Kbps
  - ITU-T V.34 at 28.8 Kbps

Whether you use the IBM modem or provide your own modem, you must set up a communications (telephone) line to the modem to use it. A workstation is required to access the IBM 2216.

The required operational software is shipped preloaded on each IBM 2216.

Hardware and Software Requirements for the Configuration Program

You can use the Configuration Program to prepare configuration files and then upload them to the IBM 2216. This method of configuration enables you to use the change management functions of the IBM 2216.

Note: Using the Configuration Program is recommended for the final configuration of the IBM 2216 (after running the "Quick Configuration" program during the installation of the IBM 2216). The Configuration Program enables you to save and track configuration files. You can also make an ASCII copy of the completed configuration file to check its parameters before you download it to the IBM 2216.

The Configuration Program will operate in any of the following hardware and software operating environments:

- An IBM Personal System/2 (PS/2) computer or compatible computer that is running Microsoft Windows and has the following attributes:

  - Intel 80386 or higher processor
  - IBM DOS 5.0 or MS DOS 5.0 or higher
  - MS Windows 3.1 or higher versions
    - Win32s, included with the Multiprotocol Access Services Configuration Program (not required for Windows 95)
    - WinSock 2.0 DLL (included with Win32s)
  - TCP/IP application that uses WinSock 2.0
  - 15 MB of memory
  - 1.44 MB, 3.5-inch diskette drive
  - 14 MB of free hard disk space
  - A graphics display that supports 640*480 resolution and 16 colors or gray scale
  - A mouse

If you encounter problems because Windows does not update correctly, make sure that you have the latest BIOS and video drivers provided by the manufacturer.

- An RS/6000 POWERstation or POWERserver with the following attributes:
  - AIX for RS/6000 Version 3.2.5 or higher with TCP/IP enabled; (program number 5756-030)
  - AIXWindows Environment/6000 (program number 5601-257)
  - 16 MB of memory
  - 1.44 MB, 3.5-inch diskette drive
  - 14 MB of free hard disk space
  - A graphics display that supports 640*480 resolution and 16 colors or grayscale
  - A mouse

If you plan to install a communication link between the Configuration Program on an RS/6000 workstation and the IBM 2216, the TCP/IP function in AIX/6000 3.2.5 (or higher) must be installed.

- An IBM PS/2 or compatible computer with the following attributes:
  - Intel 80386 or higher processor
  - IBM Operating System (OS/2) 2.1 or higher, including WARP
  - IBM TCP/IP 1.2.1 for OS/2 or higher
  - 15 MB of memory (16 MB recommended)
  - 1.44 MB, 3.5-inch diskette drive
  - 14 MB of free hard disk space
  - 10 MB of available swapper disk space on the swapper hard disk drive partition
  - A graphics display that supports 640*480 resolution and 16 colors or grayscale
  - A mouse

If you encounter problems because Windows is not updating correctly, make sure that you have the latest BIOS and video drivers provided by the manufacturer.

Physical Specifications

The dimensions of the IBM 2216 are as follows:

Width

440 mm (17.3 in.) without rack mounting flange
480 mm (18.9 in.) with rack mounting flange

Depth

358 mm (14.1 in.)

Height

572 mm (22.5 in.) (13U) without rubber feet pads
576.1 mm (22.7 in.) (13U) with rubber feet pads

Weight

The base box of the IBM 2216 (with one power supply), system card, no adapters, a power supply filler plate, and no adapter filler plates weighs 31.6 kg (69.7 lb).

- Each adapter weighs approximately 1 kg (2.2 lb).
- Each filler plate for an unoccupied adapter slot weighs 0.1 kg (0.2 lb).
- A filler plate for a second power supply weighs 0.2 kg (0.4 lb)
- A second power supply weighs 3.5 kg (7.7 lb).

A fully populated IBM 2216 with a second power supply and eight adapters will weigh about 43.1 kg (95 lb).

Note: During installation, two people will be required to lift the 2216.

Service Clearances

You must leave free space for service around the machine as follows:

Front   750 mm (30 in.)

Sides   No clearance required

Rear   No clearance required

Airflow

A multiple-fan (forced air) ventilation system is installed in each unit. The airflow is 2.0 cubic meters per minute (71 cubic feet per minute).

Operating Environment

Temperature   10°C to 40.6°C (50°F to 105°F)

Relative Humidity 8% to 80%

Max Wet Bulb   27°C (80°F)

Lightning Protection

The power supplies of the IBM 2216 are protected against lightning.

Contact an electrical contractor to determine if lightning protection is needed for your power distribution system.

Electromagnetic Interference

The IBM 2216 is compatible with the following classes of interference:

- Federal Communication Commission (FCC), Part 15, Subpart J, class A (USA)
- Comité International Spécial des Perturbations Radioélectriques (CISPR) Publication 22, Class A
- General Operating Permit (GOP) (Germany)
- Voluntary Control Council for Interference (VCCI) Class 1 and IEC 1000-3-2 (Japan)

Power Supply

The IBM 2216 can have one or two power supplies. A single power supply can provide power for a fully configured unit. The first power supply will remain fully operational while a second is either being installed or removed. The second power supply must have its power switch in the off position while it is being installed or removed. If a second power supply is not installed, a filler plate is used to cover the position where it would have been installed.

The power supply uses a voltage sensing system that converts line current of 100—240 volts ac, 50/60 Hz single-phase, to dc input as required by the system card, the adapters, and the fan tray.

Power Supply Requirements

For the IBM 2216, the ac power source must be able to supply:

- 100 to 240 V ac (nominal voltage)
- 50 or 60 Hz
- Single phase
- 0.62 kVA power
- 70 amps peak inrush current for one quarter cycle per supply

Power Cord Characteristics

The ac power cord is supplied with a country-dependent plug. For each of the cords listed in Table 3-1, find its plug type in Figure 3-1 on page 3-6 by comparing *index* numbers. (The index number is displayed below each plug type in Figure 3-1.)

Table 3-1 (Page 1 of 2). Power Cords and Power Plug Standards

Index	Part Number	Feature Code	Countries	Power Cord	Plug Standard
1	1838574	9833	Canada, Japan, Philippines, Taiwan, Thailand, Bolivia, Brazil, Ecuador, Peru, Venezuela, United States	250 V, 10 A, 2.7 m (9 ft)	NEMA WD-1 6-15P
2	6952300	9810	United States (except Chicago), Puerto Rico, Canada, Japan, South Korea, Philippines, Taiwan, Saudi Arabia, Mexico, Bolivia, Brazil, Colombia, Ecuador, Peru, Venezuela, Panama	125 V, 10 A, 2.7 m (9 ft)	NEMA WD-1 5-15P
2	6952301	9815	United States (Chicago only)	125 V, 10 A, 1.8 m (6 ft)	NEMA WD-1 5-15P
2	1838576	9818	United States (Chicago only)	250 V, 10 A, 1.8 m (6 ft)	NEMA WD-1 5-15P
3	13F9979	9820	Indonesia, South Korea, Macau, Austria, Belgium, Finland, France, Germany, Greece, Norway, Portugal, Saudi Arabia, Spain, Sweden, Turkey, Netherlands, China, Brazil	250 V, 10 A, 2.7 m (9 ft)	CEE7 VII

Table 3-1 (Page 2 of 2). Power Cords and Power Plug Standards

Index	Part Number	Feature Code	Countries	Power Cord	Plug Standard
4	14F0033	9825	Brunei, China, Hong Kong, India, Malaysia, Singapore, Ireland, Kuwait, United Arab Emirates, United Kingdom	250 V, 10 A, 2.7 m (9 ft)	BS 1363
5	14F0051	9828	Switzerland, Liechtenstein	250 V, 10 A, 2.7 m (9 ft)	SEV 24507
6	14F0069	9830	Italy, Chile	250 V, 10 A, 2.7 m (9 ft)	CEI 23-16
7	13F9997	9821	Denmark	250 V, 10 A. 2.7 m (9 ft)	Normblad 4
8	14F0087	9827	Israel	250 V, 10 A, 2.7 m (9 ft)	SII-32-1971
9	13F9940	9831	Australia, New Zealand, Argentina, China	250 V, 10 A, 2.7 m (9 ft)	AS 3122-1981 NZS 198
9	6952291	9834	Argentina, Colombia, Brazil, Paraguay, Uruguay	250 V, 10 A, 2.7 m (9 ft)	IEC 83-A5 1957
10	14F0015	9829	Bangladesh, Myanmar, Sri Lanka, Pakistan, South Africa	250 V, 10 A, 2.7 m (9 ft)	SABS 164 BS 546
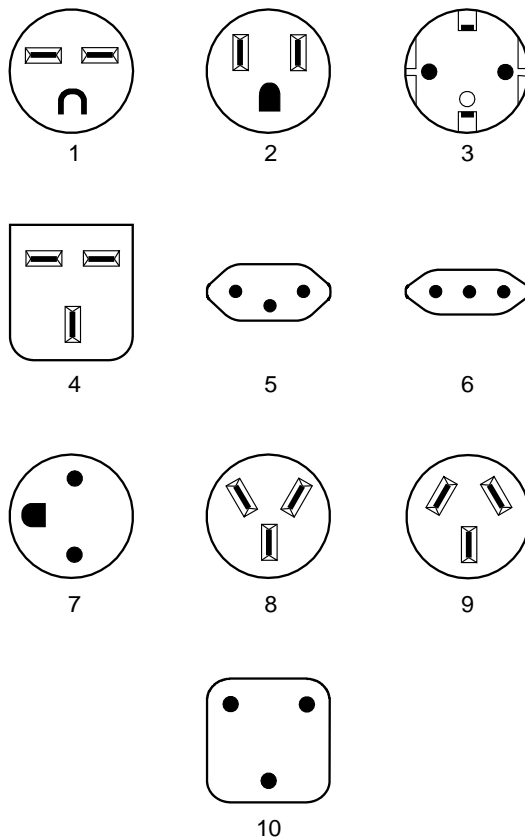
Figure 3-1. Power Cord Plugs by Country

Chapter 4. Configuration and Monitoring Tools

These are the various configuration and monitoring tools that are supported by the physical connections:

Multiprotocol Access Services Configuration Program

This is a standalone program that is installed in a workstation that is connected to the IBM 2216. The workstation must be running TCP/IP. You can transfer files to and from the configuration program using Xmodem Send, TFTP over IP or SLIP, or the Communications Options feature of the configuration program.

The Communications Options feature requires that the configuration program run over AIX and that the IBM 2216 be configured with an IP address, a subnet mask, and Simple Network Management Protocol (SNMP).

Before Configuration:

Connection to the IBM 2216 must be through the modem or the EIA 232 service port over a serial link. While the IBM 2216 is in this state, you cannot use the Communications option of the Configuration Program. You can create configuration files and download them to the IBM 2216 over the serial link using the TFTP over SLIP. The workstation must be running TCP/IP.

After Configuration:

The configuration file that you download over a serial link can provide an IP address and subnet mask to the IBM 2216.

When the IBM 2216 is in this state, you can use the Communications Send option of the Configuration Program to send configuration files from the workstation over the network to the IBM 2216. You can also use the Communications Retrieve option of the Configuration Program to retrieve configuration files from the IBM 2216.

Command line interface

The command line interface is a teletypewriter (TTY) text interface that requires you to enter commands to use it. The workstation that accesses it must be either an ASCII terminal or a personal computer (PC) or other programmable workstation emulating an ASCII terminal.

The command line interface can also be accessed using telnet over a SLIP or an in-band IP connection. The IBM 2216 can support two connections at one time if one connection is a telnet session.

The command line interface is marked by an asterisk (*) prompt. Refer to the *Multiprotocol Access Services Software User's Guide* for a full description of this interface.

Important: If you use a serial connection (either local or remote), you **must press a key** to display the asterisk prompt for the command line interface.

When you make the connection, the message:

```
 Please press a key to obtain console
```

appears to remind you to do this.

PCMCIA Modem

The modem is an integrated PCMCIA modem that handles data from the IBM 2216. It provides remote connection that supports either the TTY or SLIP access.

IBM 2216 Access Methods

Access to the IBM 2216 is provided to enable you to install the operational software and to configure, monitor, control, and maintain the product using software that is provided with it.

Local and Remote Console Access

When accessing the IBM 2216 locally on a null modem cable that is attached to the EIA service port or remotely through the PCMCIA modem, use VT100 terminal emulation. Because VT100 does not define function keys above F4, edit the keyboard mapping manually as follows:

- For F6, enter the mapping (ESC)OU.
- For F9, enter the mapping (ESC)(Left square bracket)00q.

  Note: (ESC) represents the carat symbol followed by the left square bracket. Also note that the PING done at the PCMCIA modem may take up to 2 minutes.

System Components Used for Access to the IBM 2216

These components include the IBM 2216 hardware and the Configuration Program.

IBM 2216 Hardware

The IBM 2216 itself is the first system component. Once the IBM 2216 has been loaded with its operational software and has been configured, it can restart from the operational software that is stored within it. It has sufficient non-volatile storage to maintain two copies of its operational software and four copies of the configuration file for each operational software load image (8 total configuration files in data areas known as *banks*). It also possesses non-volatile storage areas for logs as well as system support data areas.

Command Line Interface: This interface, known as *Operator control module (OPCON)*, appears when you telnet into the service port or when you attach an ASCII terminal or terminal emulator to the service port either locally or remotely. OPCON provides the basic console support for the IBM 2216. The services OPCON provides include:

- Login authentication.

- Displaying the status of system processes. This means that the command line interface can show you which processes of the OPCON are currently active. The OPCON processes are the functions of OPCON, for example, *Config*, which is the configuration process, and *GWCON*, which is the most frequently used monitoring process. The command **talk 6** brings up the configuration process and the command **talk 5** brings up the GWCON monitoring process.

  From the Config process you can bring up the event logging system (ELS), which displays system error messages.

- Displaying statistics including:
    - Packets forwarded
    - Memory utilization
    - Uptime
    - Last restart or reboot
    - Detailed interface error counters
    - Protocol status (routing tables) and error counters
    - ATM Virtual Circuit Connection statistics

- Controlling the output from a process.

- Stopping the output from a process.

Refer to the two volumes of the *Nways Multiprotocol Access Services Protocol Configuration and Monitoring Reference* for a full description of the command line interface.

Configuration Program

This graphical user interface tool provides an offline application for the configuration of the IBM 2216. It is installed in a workstation that is attached to the IBM 2216 service port, either remotely or locally. Requirements for the Configuration Program are listed in "Hardware and Software Requirements for the Configuration Program" on page 3-2.

PCMCIA Modem

This interface is intended for remote installation, network management, and service access to the IBM 2216. The PCMCIA modem is available in most countries. In a few countries, the modem is not available. See "Hardware Requirements" on page 3-2 for more information.

Chapter 5. Network Planning

This chapter includes sample network diagrams and planning considerations. It currently contains network diagrams only for ESCON.

Planning for the ESCON Channel Adapter

This chapter describes how to plan for the installation of the 2216 ESCON Channel Adapter. It includes the following topics:

- "ESCON Channel Adapter Functions"
- "Introduction to Host Planning for the 2216" on page 5-6
- "Determining Your System Requirements" on page 5-8
- "2216 Planning Considerations" on page 5-22

The *Multiprotocol Access Services Software User's Guide* provides details for con-figuring the host and the 2216 for use with the ESCON Adapter.

ESCON Channel Adapter Functions

The ESCON Channel Adapter (FC 2287) provides the IBM 2216 with access to SNA and TCP/IP host applications from LANs, WANs, and ATM over a duplex-to-duplex multimode fiber-optic cable.

The 2216 LAN/WAN Gateway

A 2216 with an ESCON Channel Adapter that provides access for LAN-to-host applications is called a *2216 LAN/WAN gateway*.

The 2216 LAN gateway gives LAN devices concurrent access to VTAM and TCP/IP programs running on host computers.

Figure 5-1 on page 5-2 represents a possible environment consisting of 2216s, hosts, and LAN devices (it is only a sample configuration).

TCP/IP
CM/2
AIX

NetView/
6000

Host
TCP/IP
VTAM
Other

LANS:
Token-Ring
Ethernet/802.3
FDDI

2216

TCP/IP
CM/2
AIX

Host

2216

ESCON
Channel

Sessions:
TCP/IP Suite
APPN
APPC
OSI
3270 Emulation
Others

TCP/IP	FTP TELNET SMTP RPC NFS AnyNet	X Window System REXEC OSF/MOTIF LPR/LPD SNMP Agent NCS	CICS SOCKETS KERBEROS NAME SERVER SNMP Client RouteD (RIP)
VTAM	IMS/ESA VM/CMS AnyNet	CICS/ESA MVS/TSO APPC	
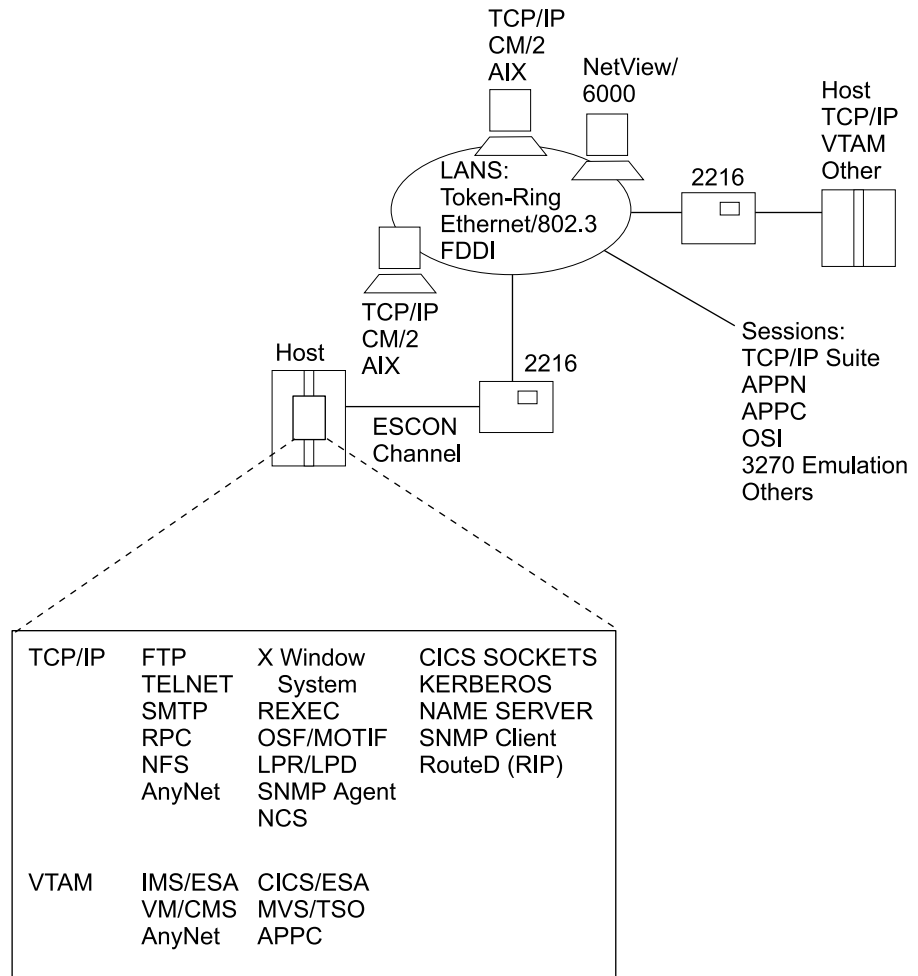
Figure 5-1. Representative Network Containing the 2216

The 2216 LAN/WAN gateway with ESCON Channel Adapter supports the following communications:

- Between a LAN/WAN device and a host, through a 2216 (LAN/WAN-to-host)
- From a device on one LAN/WAN to a device on a different LAN/WAN, with host routing support.

See Table 5-1 on page 5-5 for more information on LAN/WAN devices.

In both cases, LAN/WAN-to-channel connections in the 2216 are defined as part of the host and 2216 configurations. Each host program (using either one subchannel or a pair of subchannels, depending on the host program type) communicates through a LAN/WAN adapter in the 2216.

The host and LAN/WAN device can each be one of the following:

- A TCP/IP client, server, or IP router.

  Note: This support is provided by Logical Channel Station (LCS) virtual network handlers in the 2216.

- A PU 5 (VTAM), PU 2.0, PU 2.1, APPN End Node (EN), or Network Node (NN) Both APPN ISR and HPR flows are supported.

  Note: This support is provided by Link Services Architecture (LSA) virtual net handlers in the 2216.

The LAN/WAN device can also be a PU 4 with the IBM Network Control Program (NCP) on the IBM 3745 or 3746 Communication Controller.

Multi-Path Channel+ (MPC+) Support

The 2216 provides one level of MPC support, *High Performance Data Transfer (HPDT)*, also referred to as *MPC+*. HPDT MPC connections provide more efficient transfer of data than non-HPDT MPC connections.

The 2216 Multi-Path Channel support, which is called Multi-Path Channel+ (MPC+), provides more efficient transfer of data by using high-performance data transfer (HPDT) services (in VTAM) to provide data packing without data movement and chain scheduling of programs. While MPC+ in the 2216 does not fully make use of HPDT services (that is, it does data movement), it does support receiving data that fully uses the HPDT services in VTAM.

The level of MPC used for an MPC connection is automatically determined by negotiation between the partner nodes.

When HPDT MPC Is Used

If both partner nodes support HPDT MPC, HPDT MPC is automatically used.

- The 2216 only supports HPDT MPC (also known as MPC+).

- You can control the level used in VTAM by coding the MPCLEVEL operand on the TRLE definition statement that defines the MPC connection. VTAM supports HPDT MPC if it is defined as an HPR APPN node that provides RTP-level HPR support.

  Note: Keep in mind that pre-V4R4 VTAMs do not support HPDT MPC.

When Non-HPDT MPC Is Used

If either partner node does not support HPDT MPC, non-HPDT MPC is automatically used.

The 2216 does not support non-HPDT MPC.

Multi-Path Channel+ (MPC+) connections allow you to code a single transmission group (TG) that uses multiple write-direction and read-direction subchannels. Because each subchannel operates in only one direction, the half-duplex turn-around time that occurs with other channel-to-channel connections is reduced. The 2216 MPC+ does not allow the subchannels of an MPC+ group to be on more than one physical channel.

If at least one read and one write path is allocated successfully, the MPC+ channel connection is activated. Additional paths (defined but not online) in an MPC+ group can later be dynamically added to the active group using the MVS VARY ONLINE command. For example, if there is a need for an increase in capacity to allow for

extra traffic over a channel, additional paths can be added to the active group without disruption. Similarly, paths can be deleted from the active group when no longer needed using the MVS command VARY device OFFLINE.

The 2216 MPC+ supports APPN HPR, TCP/IP and HPDT for UDP.[1]

Note: For the 2216 ESCON Channel Adapter, the terms *MPC+ Group* and *MPC+ Virtual Interface* mean the same thing.

2216 ESCON Functional Support

Depending on the environment, a 2216 with an ESCON Channel Adapter gives host applications access to different types of LANs/WANs. The particular networks supported depend on the communication protocols being used, which host applications they are used with, and which operating systems are supported.

2216 ESCON software provides support for TCP/IP applications and VTAM applications to LAN/WAN devices including Token-Ring, IEEE 802.3, and Ethernet V2.

Table 5-1 on page 5-5 illustrates the 2216 connections provided for each host program. The supported environments are grouped by protocol. The table shows the host programs and adapters that provide each protocol support. For each of these host environments, the adapters that can be used are indicated with a Y in the table.

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[1] The TCP/IP & HPDT for UDP+ over MPC+ is available in Version 2 Release 2 of the Nways Multiprotocol Access Services (MAS) licensed program, which is the code that runs on the 2216.

Table   5-1. ESCON Functional Support for 2216

	TCP/IP [1] (LCS) Gateway	HPDT for UDP MPC+ [4]	TCP/IP for MPC+ [5]	VTAM [2]			
				SNA (LSA) Gateway	APPN ISR	APPN HPR MPC+ [3]	DLSw
Token-Ring	Y	Y	Y	Y	Y	Y	Y
Ethernet V2	Y	Y	Y	N	Y	Y	Y
Ethernet 802.3	Y	Y	Y	Y	Y	Y	Y
FDDI	Y	Y	Y	Y	Y	Y	Y
Serial PPP	Y	Y	Y	N	Y	Y	Y
Serial FR: bridged	N	N	N	N	Y	Y	Y
routed	Y	Y	Y	N	Y	Y	N
SDLC	N	N	N	N	Y	N	Y
X.25	Y	Y	Y	N	Y	N	Y
ATM LANE	Y	Y	Y	Y	Y	Y	Y
ATM Classical IP	Y	Y	Y	N	N	N	Y

Notes:

1. TCP/IP 2.2 or higher.
2. ESCON support requires an ESA operating system (V3R4 or higher).
3. APPN HPR over MPC+ requires VTAM V4R4 and APPN HPR. VTAM V4R4 requires the following PTFs:

   UW36478   UW36159   UW36490   UW36495   UW36245   UW36265   UW36540
   UW36537   UW36564   UW36612   UW36614   UW36861   UW37958   UW38105

4. HPDT for UDP over MPC+ requires: VTAM V4R4 at the level described for APPN in step 3. TCP/IP OpenEdition with APAR/PTF PQ03737. (The TCP/IP & HPDT for UDP+ over MPC+ is available in Version 2 Release 2 of the Nways Multiprotocol Access Services (MAS) licensed program, which is the code that runs on the 2216.)
5. TCP/IP for MPC+ requires: VTAM V4R4 at the level described for APPN in step 3 with the addition of APAR/PTF OW26845 and TCP/IP OpenEdition with APAR/PTF OW04890. (The TCP/IP & HPDT for UDP+ over MPC+ is available in Version 2 Release 2 of the Nways Multiprotocol Access Services (MAS) licensed program, which is the code that runs on the 2216.)
6. HPR over LSA requires: VTAM APAR number OW26732. It is only supported on VTAM V4R4.

Channel and Network Connections

The following ESCON channel connections are supported:

- ES/3090J Processor (selected models)
- 9021 ES/9000 Processor
- 9121 ES/9000 Processor
- 9221 ES/9000 Processor
- 9032 and 9033 ESCON Directors
- 9036 ESCON Remote Channel Extender
- 9672 System/390 Parallel Enterprise Server
- 9729 Optical Wavelength Division Multiplexor
- 2003 System/390 Multiprise 2000

Introduction to Host Planning for the 2216

Table 5-2 summarizes the protocols, channels, networks, and management functions supported by the 2216 with an ESCON Channel Adapter.

Table 5-2. 2216 ESCON Functional Summary

Communications Protocols	**Channels and Networks**	**Management**
• TCP/IP	• ESCON Channel	• SNMP Client
• Subarea SNA	• Token-Ring Network	
• APPN ISR	• Ethernet V2 Network	
• APPN HPR	• IEEE 802.3 Network	
• DLSw	• ATM LANE	
• HPDT for UDP	• Frame Relay	

The 2216 offers a solution for customers with traditional hierarchical (host-centric) networks as well as those customers who are migrating to flat (network-centric) networks. Figure 5-2 on page 5-7 illustrates the latter, showing a local LAN and remote LAN gaining access to an existing hierarchical network (depicted by the cloud) through a 2216 with an ESCON Channel Adapter.

SNA or TCP/IP Network

Host   Host

DLSw Router

2216   2216

APPN T
C
P

Ethernet

WAN   Ring

DLSw

FDDI   Token-Ring   ATM

2210/   2210/
2216   2216

Token-Ring

Frame Relay

RoutExpander/2
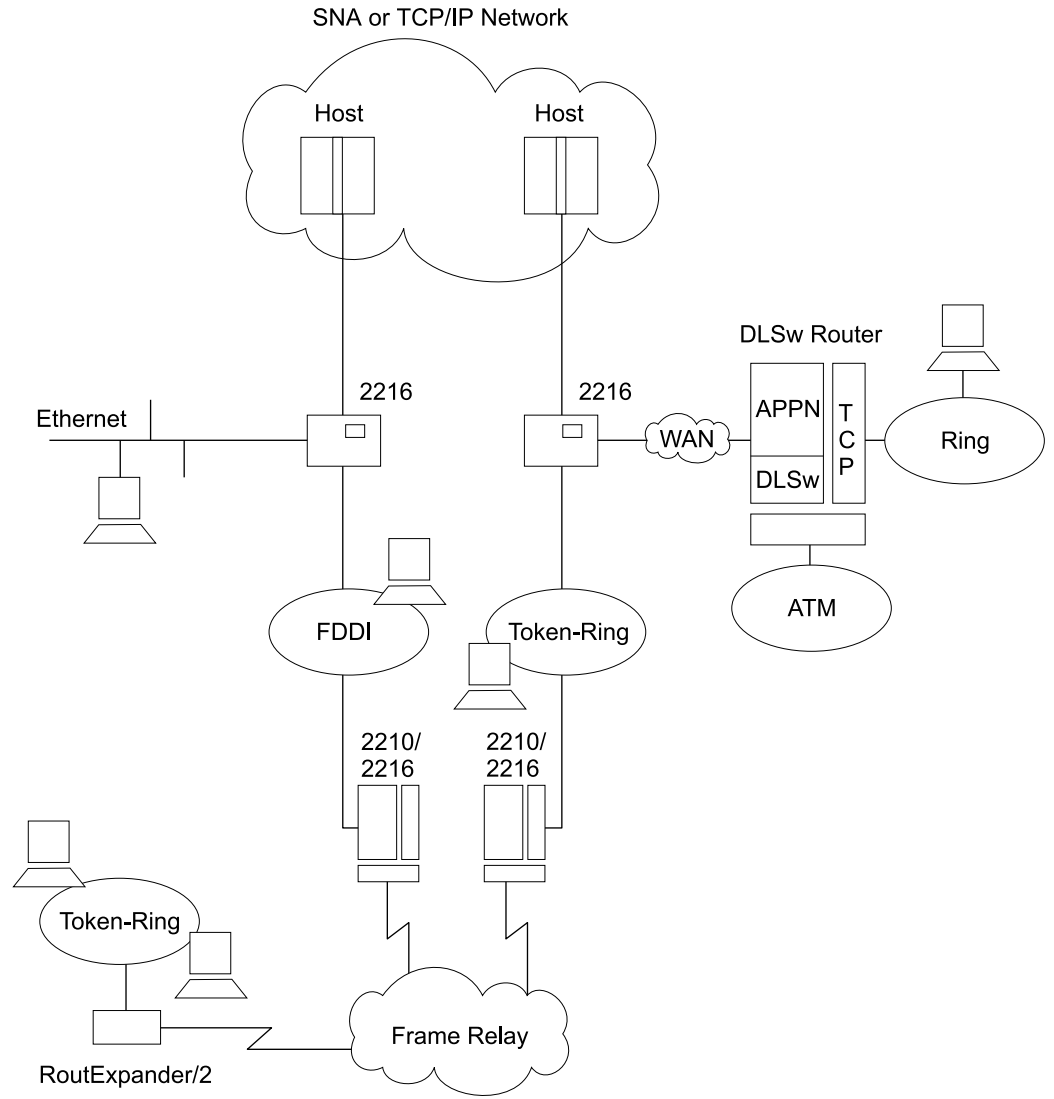
- All workstations can talk to all hosts.
- All workstations can talk to each other.

Figure   5-2. IBM 2216 with ESCON Channel Adapter in a Network

Determining Your System Requirements

You will need a license for each 2216 that you install. To help you decide the number of 2216s that you require, consider:

- What channel support is required?
- How many hosts, host programs, and users do you need to support?
- How many physical channel and LAN connections do you need to make?
- How many LAN/WAN gateway connections do you need to define?
- How can you achieve high 2216 availability and hardware backup?
- How many logical host images will require connection to the 2216?

The following sections provide information to help you determine how many 2216s you need.

Channel Support

This section describes the characteristics of host channel support to help you understand how your host connection choices affect your 2216 needs.

ESCON Channel Characteristics and Configuration Examples: The 2216 with an ESCON adapter provides the following support:

- A maximum of four ESCON Channel Adapters per 2216.

- A maximum of 32 logical paths (ESCON subchannels) per 2216 ESCON Channel Adapter to the connected hosts. These logical paths can be defined to the same ESCON channel or divided among multiple ESCON channels.

- EMIF support for sharing ESCON channels for connection to multiple host images in LPAR-capable hosts. This support can be used with the IBM ESCON Directors connecting to multiple hosts, or for direct connection to a single host processor.

- A maximum of two IBM 9032 or 9033 ESCON Directors (ESCDs) in the path between the 2216 ESCON Channel Adapter and the host.

- Distances of up to 43 km (26.7 miles) using the ESCON Extended Distance Feature (XDF) available on host processors, ESCDs, and ESCON Remote Channel Extenders.

The following examples illustrate various 2216/ESCON configurations:

- Single and direct attachment between a S/370 or S/390 processor and 2216s

  See Figure 5-3 on page 5-9.

- Multiple systems attachment with ESCDs

  See Figure 5-4 on page 5-10.

- EMIF attachment between a S/370 or S/390 processor and 2216s.

  See Figure 5-5 on page 5-11.

Direct Attachment Between a S/390 Host and a 2216: In Figure 5-3, connection A shows a 2216 directly attached to a S/390 host channel. The separation of the host and the 2216 can be up to 3 km (1.86 miles).

Single Attachment Between a S/390 Processor and 2216s: Connections A, B, C, and D show 2216s attached to a single host.

The maximum distance between the S/390 host and the 2216 can vary from 3 km (1.86 miles) to 43 km (26.7 miles). For connection A, a maximum distance of 3 km (1.86 miles) can be achieved without ESCDs between the host and 2216. For connection B, a maximum distance of 9 km can be achieved with two ESCDs connected with multimode fiber. As shown in connections C and D, distances of up to 43 km can be achieved by using 9032 or 9033 ESCDs with the XDF or a combination of ESCDs and 9036 Remote Channel Extenders. The host must also have the XDF.

When two ESCON Directors are serially attached, the connection through one of the directors must be dedicated.

Figure 5-3. Single System ESCON Connection Example

Multiple Systems Attachment with ESCDs: Figure 5-4 shows the connection of multiple S/390 hosts to single and multiple 2216s, with possible backup paths. A fault-tolerant solution can be designed using backup channels, multiple ESCDs, and/or multiple 2216s.

For additional information, see "2216 Availability and Backup" on page 5-16.
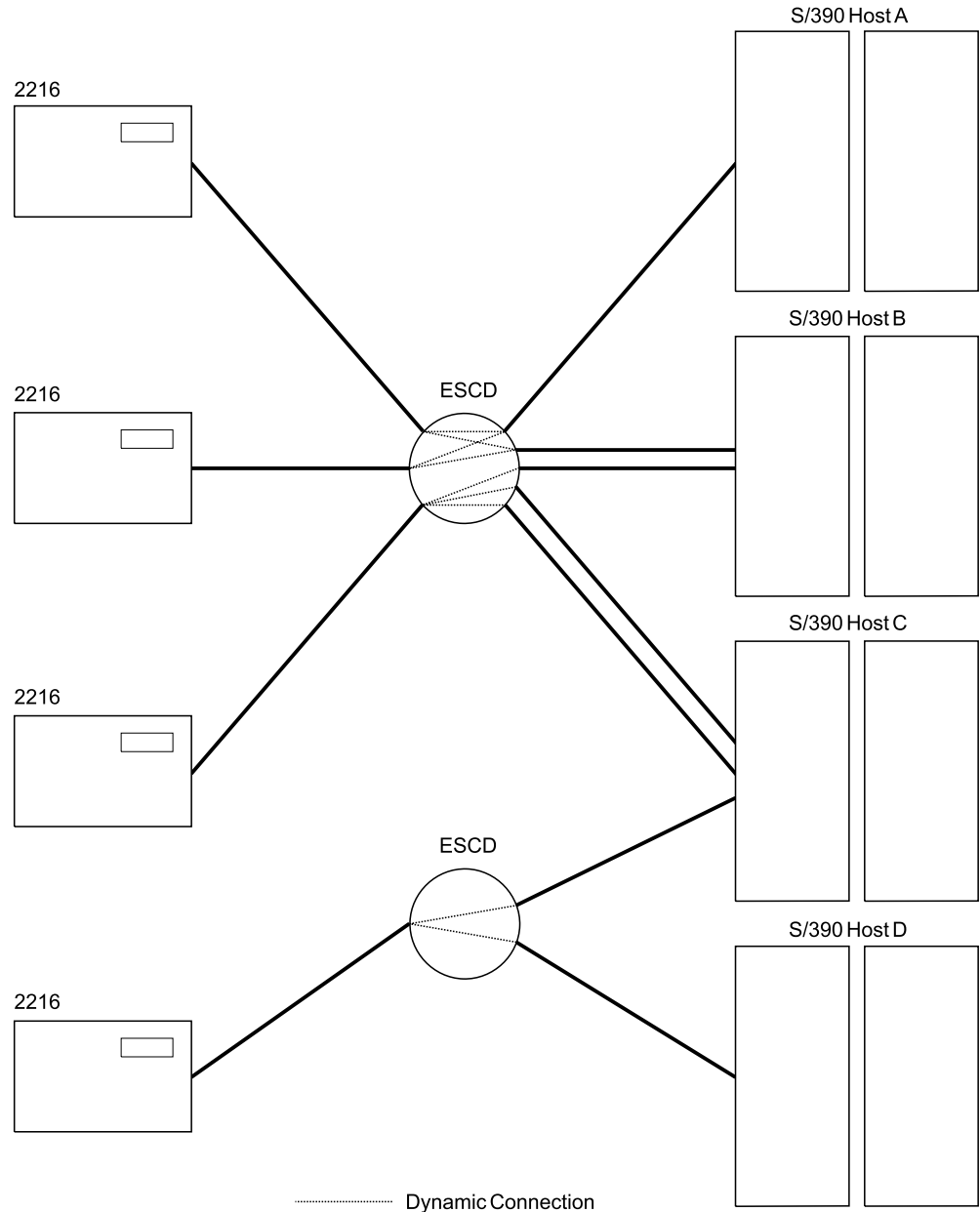
Figure 5-4. Multiple System ESCON Connections Example

EMIF Attachment Between an ES/9000 Processor and a 2216: The ESCON Multiple Image Facility (EMIF) allows the sharing of ESCON channels across Processor Resource/Systems Manager (PR/SM) logical partitions (LPs). Prior to EMIF, dedicated channels to each logical partition were required.

EMIF is supported on all ES/9000 Model 511/711-based processors, and on the Model 520-based processors.

The 2216 ESCON Channel Adapter supports EMIF connectivity. This connection can be either direct host attachment or through an ESCD, and the logical hosts can be on the same or different physical hosts.

Figure 5-5 shows 2216 connectivity to an LPAR host. Logical hosts A and B are connected directly to the 2216. Logical hosts B, C, and D are connected to multiple 2216s with a single ESCON connection from the ESCON Director. Each of these 2216s can be connected to logical hosts B, C, and D.

☐ 2216 with an ESCON Channel Adapter
○ ESCON Director (ESCD) (9032/9033)
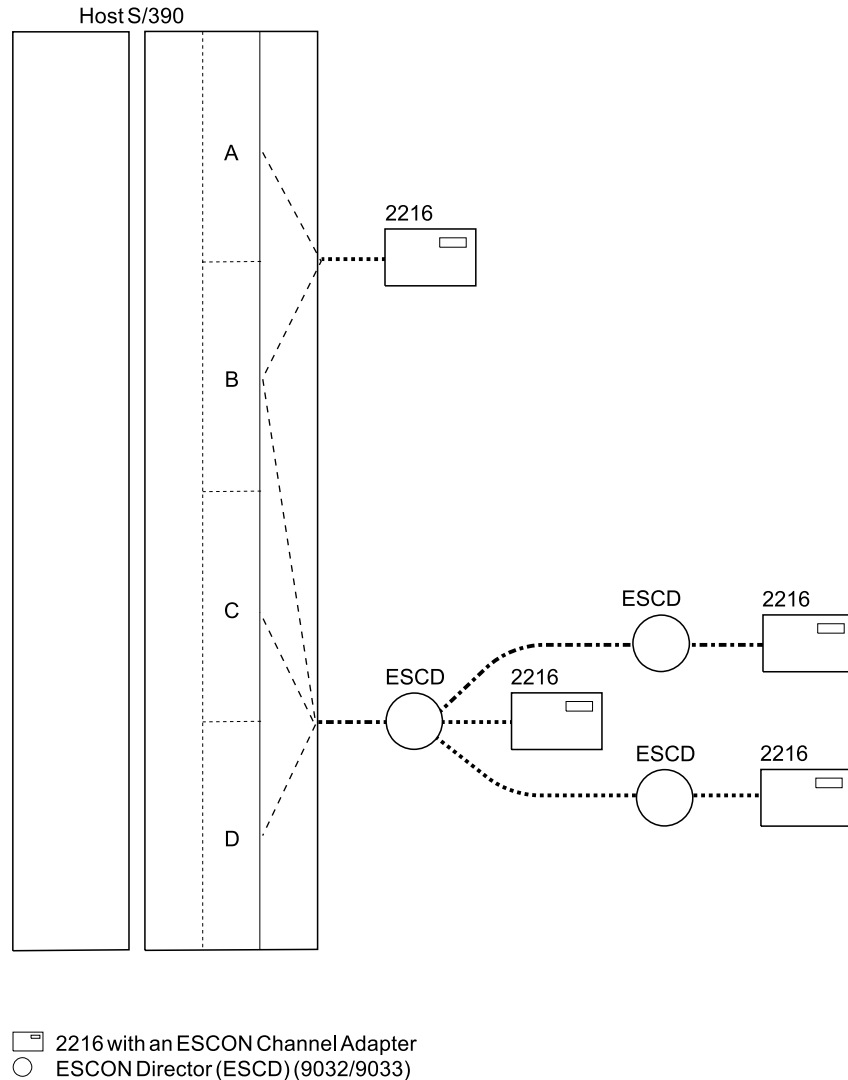
Figure 5-5. 2216 EMIF Attachment Example

Number of Hosts, Host Programs, and Users

Your channel and LAN/WAN choices affect the number of hosts and host programs that each 2216 can support. Also, your host program choice affects the number of users that can be supported by each 2216.

Number of Hosts: The number of hosts (or the number of logical partitions in a single host) that you can configure to use with one 2216 is influenced by several factors.

For ESCON hosts that are attaching to a 2216, the 2216 must have at least:

- One LSA subchannel for each host (or logical partition) running VTAM programs that are not using MPC+

- One LCS interface (two subchannels) for each host (or logical partition) connecting to TCP/IP using LCS

- Two subchannels for each host (or logical partition) that will be communicating with the 2216 using MPC+

Refer to "Limits for 2216 ESCON Network Interfaces and Subchannels" on page 5-13 for more information about the limits mentioned here.

Number of Host Programs: The number of host programs that can run using a 2216 is less restrictive than the number of hosts that can use a 2216. This allows you to run more than one VTAM or TCP/IP host program on the same host (or in the same logical partition) using the same 2216.

For host programs that need to access a 2216, the 2216 must have at least:

- One subchannel (or subchannel pair) for each host program instance
- One LCS interface for each TCP/IP program using an LCS interface.

Be aware that multiple VTAMs can share an LSA interface. If more than one VTAM needs to use the same LSA interface, each VTAM needs to open a different SAP.

Refer to "Limits for 2216 ESCON Network Interfaces and Subchannels" on page 5-13 for more information about the limits mentioned here.

Limits for 2216 ESCON Network Interfaces and Subchannels

Subchannels will be associated with network interfaces when you configure the 2216 with an ESCON Channel Adapter.

A few simple rules govern the network interfaces:

1. Up to 16 interfaces can be configured.

2. Up to 32 subchannels can be used per ESCON Channel Adapter.

3. One LCS interface is required for each host (or logical partition) connecting to TCP/IP with the LCS interface.

4. One or more subchannels are used for each VTAM host LAN/WAN gateway (LSA).

5. Two or more subchannels are required for each MPC+ interface.

6. EMIF provides attachment to multiple host images in LPAR-capable processors using a single host ESCON port. Attachment to multiple hosts including LPAR hosts is provided using an IBM 9032 or 9033 ESCON Director.

7. VTAM (LSA) interfaces must be defined as either SNA gateway (TR, EN, FDDI, ATM LANE) or loopback (APPN or DLSw). Gateway LSA interfaces are associated with a specific LAN or LANE interface. LSA loopback interfaces can be used for both APPN (with ISR and HPR) and DLSw. An LSA interface cannot be both loopback and SNA gateway.

8. Each LCS interface must have a unique subnet address.

9. Each MPC+ interface (also known as an MPC+ group) must have at least two subchannels, one for reading and one for writing. If VTAM has the subchannel configured as "read," then the MPC+ group in the 2216 must have the subchannel configured as "write."

10. MPC+ groups cannot share subchannels with other MPC+ groups.

11. If the MPC+ Group is going to be used for HPDT for UDP, it must be coded for the exclusive use of that protocol. That is, the MPC+ Group will not be able to be shared with APPN or TCP/IP protocols. (The TCP/IP & HPDT for UDP+ over MPC+ is available in Version 2 Release 2 of the Nways Multiprotocol Access Services (MAS) licensed program, which is the code that runs on the 2216.)

12. Each LSA interface can support up to 2048 LLC link stations per SAP. An LSA interface can support multiple SAPs.

Sample Illustration of the Rules for LCS and LSA Subchannels: Figure 5-6 illustrates valid uses of subchannels by LAN adapters, according to these rules, for LCS and LSA.
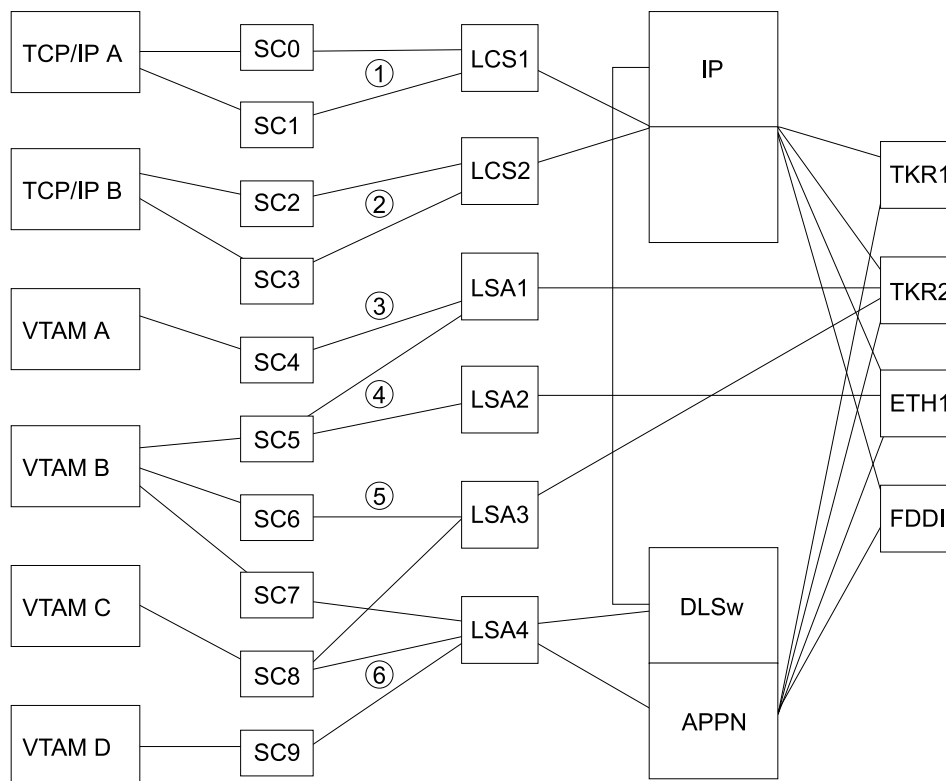
Figure   5-6. Rules for LAN/WAN Gateway Definitions for LCS and LSA Subchannels

1   LCS interface 1 uses subchannels 0 and 1 and provides access to all LAN interfaces for TCP/IP host A.

2   LCS interface 2 uses subchannels 2 and 3 and provides access to all LAN interfaces for TCP/IP host B.

3   LSA interface 1 uses subchannels 4 and 5 and provides access to TKR2 for VTAM hosts A and B, respectively.

4   LSA interface 2 uses subchannel 5 and provides access to ETH1 for VTAM host B.

5   LSA interface 3 uses subchannels 6 and 8 and provides access to TKR2 for VTAM hosts B and C.

6   LSA interface 4 uses subchannels 7, 8, and 9 and provides APPN ISR and DLSw access to all LAN interfaces for VTAM hosts B, C, and D, respectively.

Sample Illustration of the Rules for MPC+ Subchannels: Figure 5-7 illustrates valid uses of subchannels for MPC+.
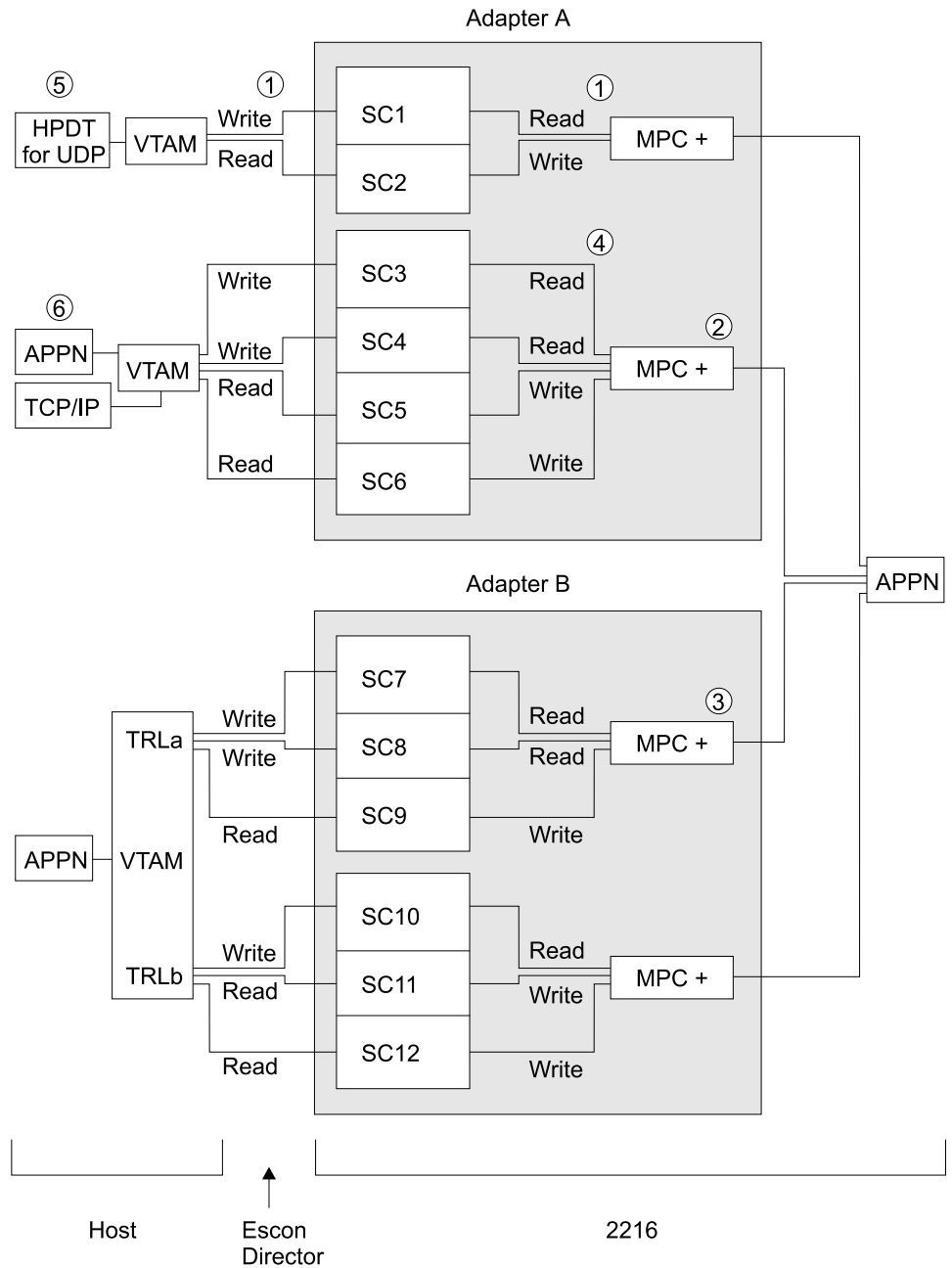
Figure 5-7. Rules for Definitions for MPC+

1 A subchannel that is configured as a "write" subchannel in VTAM is a "read" subchannel in the 2216 ESCON configuration.

2 There can be multiple MPC+ Groups on the same ESCON Channel Adapter.

3 Parallel MPC+ groups are supported but each must be placed in a separate TRL entry in the VTAM definition.

4   Although you must have at least two subchannels (one read and one write) you can have more if there is at least one read subchannel and one write subchannel.

5   HPDT for UDP cannot share its MPC+ Group with other protocols.

6   An MPC+ Group can be shared by multiple protocols as long as none of them is HPDT for UDP.

2216 Availability and Backup

In an environment where high availability is required, redundant 2216s can be used for backup.

LCS and LSA Examples: To recover from host failures, a secondary host and a path to that host are required. In Figure 5-8, if Host A fails, users have access to Host B through 2216B. When Host A recovers, user access to Host A can be restored. This is just one example of recovering from a host failure. For host failures, other factors should also be considered, such as availability of applications and data on the secondary host.

To recover from 2216 failures, a second 2216 must be in the path to your hosts. In Figure 5-8, when 2216A fails, users of Host A could be rerouted through 2216B, because there are two paths to Host A. When 2216A recovers, users of Host A could be rerouted back through 2216A. There is only one path to Host B; and if 2216B fails, users will not be able to access Host B. This could be resolved by connecting and configuring Host B to 2216A. When 2216B recovers, user access to Host B could be restored. Again, other variations of this example could be employed to recover from 2216 failure.

The backup configuration in Figure 5-8 on page 5-17 is designed as follows:

- Host A has access to LAN Segment A through 2216A, and to LAN Segment B through 2216B or 2216A.

- Host B has access to LAN Segment A and to LAN Segment B through 2216B.

- The node address for 2216A and 2216B is the same address. The node addresses can be different for TCP/IP, but not for SNA.

- The IP address for 2216A and 2216B is the same address.

- LAN Segment A and LAN Segment B are connected by a bridge or router.

   For TCP/IP, a router cannot be used. Using a router would, by design, require the IP addresses for 2216A and 2216B to be different. The IP addresses for the 2216s must be the same so that the LAN devices can rediscover the route to the secondary 2216.

Figure 5-8 on page 5-17 and Figure 5-9 on page 5-18 show sample Token-Ring LAN segments, but the same principles apply to all the LAN types supported by the 2216.
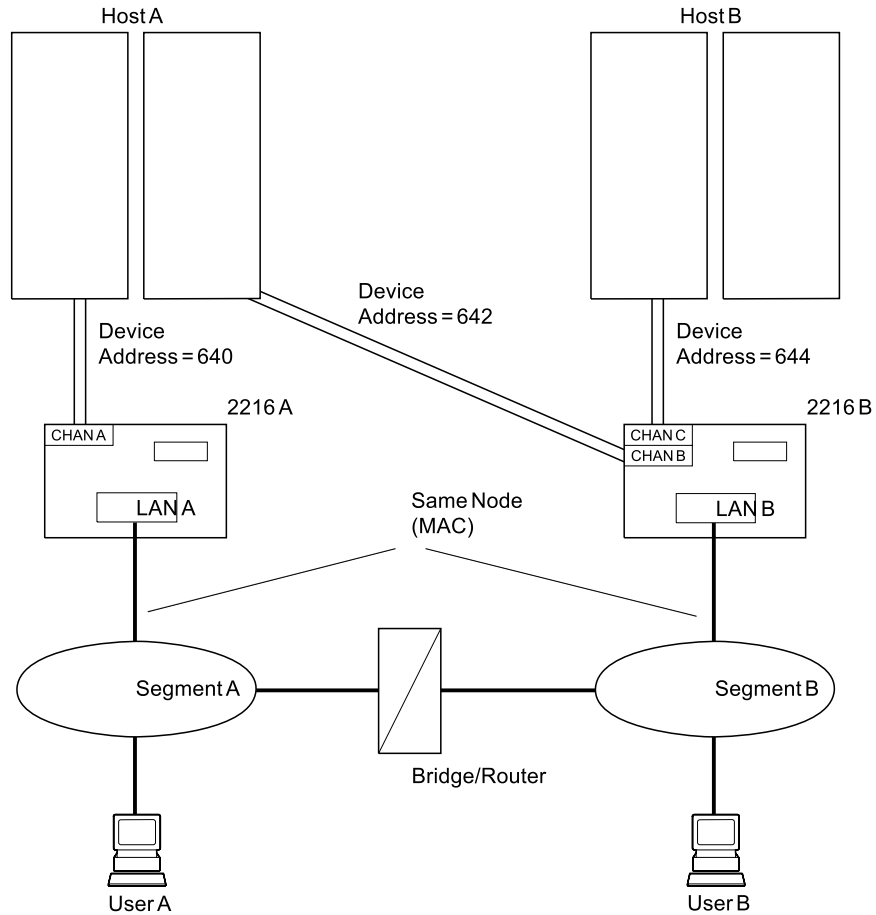
Figure   5-8. 2216 and Host Backup Using Two LAN Segments

Figure 5-9 provides the same host and 2216 backup as Figure 5-8 on page 5-17, except that:

- 2216A and 2216B are connected to the same LAN segment.
- The primary 2216 must finish IPL before the secondary 2216 is restarted. Then the secondary LAN adapter will not become active on the LAN, because the node addresses are the same.
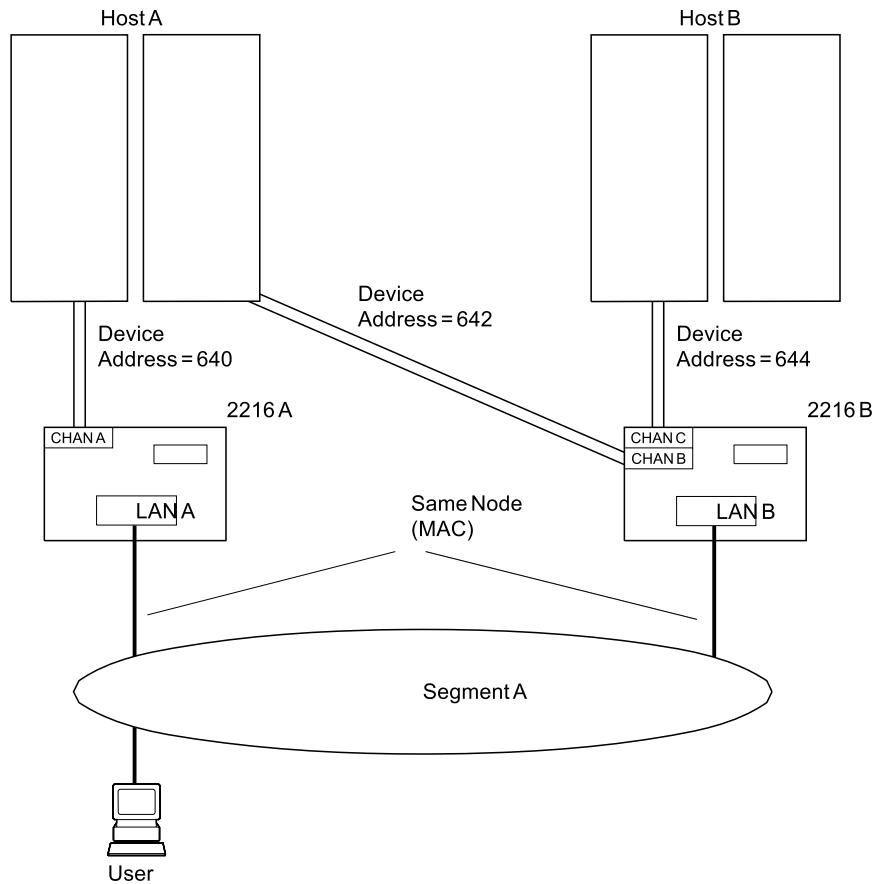
Figure 5-9. 2216 and Host Backup Using One LAN Segment

Increasing Availability in VTAM Environments: To demonstrate backup in the VTAM environment using the system in Figure 5-8 on page 5-17, assume that both 2216s and hosts are operational and that 2216A and Host A are being used as the primary system. Only the XCA major node for 2216A is active.

If 2216A fails:

1. From Host A, deactivate the XCA major node for 2216A.
2. From Host A, activate the XCA major node for 2216B.
3. Host A users experience a temporary session loss, but connect through 2216B using the same node address.

If Host A fails:

1. 2216A detects the inactive host.
2. From Host B, activate the XCA major node for 2216B.
3. Host A users experience a temporary session loss, but connect to Host B through 2216B using the same node address.

In both cases, after the failure is corrected, sessions can be moved from 2216B to 2216A in a similar manner.

To demonstrate backup in the VTAM environment using the system in Figure 5-9 on page 5-18, assume that both hosts and both 2216s are operational, and that host A and 2216A are being used as the primary system.

If 2216A fails:

1. From 2216A, issue a 2216 command to remove 2216A from the LAN (stop the LAN-A adapter).

2. From 2216B, issue a 2216 command to attach 2216B to the LAN (start the LAN-B adapter).

3. From host A, activate the XCA major node for 2216B.

4. Host A users experience a temporary session loss, but reconnect through 2216B using the same node address.

If Host A fails:

1. From 2216A, issue a 2216 command to remove 2216B from the LAN (stop the LAN-A adapter).

2. From 2216B, issue a 2216 command to attach 2216B to the LAN (start the LAN-B adapter).

3. From Host B, activate the XCA major node for 2216B.

4. Host A users experience a temporary session loss, but connect to Host B through 2216B using the same node address.

In both cases, after the failure is corrected, sessions can be moved from 2216B to 2216A in a similar manner.

Increasing Availability in a TCP/IP Environment: To demonstrate backup in a TCP/IP environment using the system in Figure 5-8 on page 5-17, assume that both 2216s and hosts are operational and that 2216A and host A are being used as the primary system.

The TCP/IP Profile data set in the host includes the following statements:

Note: The default name for the TCP/IP profile data set is TCPIP.PROFILE.TCPIP for MVS and PROFILE TCPIP for VM.

- DEVICE statements for both 2216s attached to host A (subchannels 640 and 642)

- LINK statements for the LAN adapters in both 2216s

- A HOME statement only for the LAN-A adapter

- A GATEWAY statement for your routing table that includes the LAN-A adapter

- A START statement for the device using the LAN-A adapter.

If 2216A fails, the OBEYFILE command can be executed from host A to give users access to host A through 2216B. You will need to issue a PING command to one device ***after*** the obey file has been used. You will need an obey file that contains:

- A STOP statement for the LAN-A adapter

  The STOP statement deactivates ***all*** LAN adapters that are associated with that device. Therefore, if another LAN adapter was defined in 2216A for device 640, a STOP for device 640 would stop both the LAN-A adapter and the other adapter. Depending on the type of 2216 failure, you may have to stop the LAN-A adapter using a 2216 command and execute the OBEYFILE command again.

- A HOME statement for the LAN-B adapter with the same IP address that is used for the LAN-A adapter
- A GATEWAY statement for your routing table that includes the LAN-B adapter
- A START statement for the device using the LAN-B adapter.

A similar obey file can be used to restore user access to host A when it recovers.

These steps can also be followed using the system in Figure 5-9 on page 5-18.

TCP/IP host backup is not illustrated in Figure 5-8 on page 5-17 or Figure 5-9 on page 5-18. Because each TCP/IP host requires its own LAN adapter, you will not be able to recover from TCP/IP host failures as you can with VTAM hosts. You can, however, add a LAN adapter to either 2216 (or both if you want a backup for both hosts) and define a connection between the host and LAN adapters.

- These new adapters will not have the same node (or MAC) address as the adapters for your primary hosts (shown in Figure 5-8 on page 5-17 and Figure 5-9 on page 5-18).
- The adapters for the backup host will need to use the same IP addresses that you used for the primary hosts. You can switch the IP/LAN adapter association when one host fails in a similar manner as you do for 2216 failures described above.

For more information about TCP/IP configuration, see "ESCON-Related Publications" on page 5-26. Refer to "Host Definition Planning" in the *Multiprotocol Access Services Software User's Guide* for information related to configuring.

MPC+ *Examples:* Figure 5-10 shows an example of backup for Multi-Path Channel+ (MPC+).
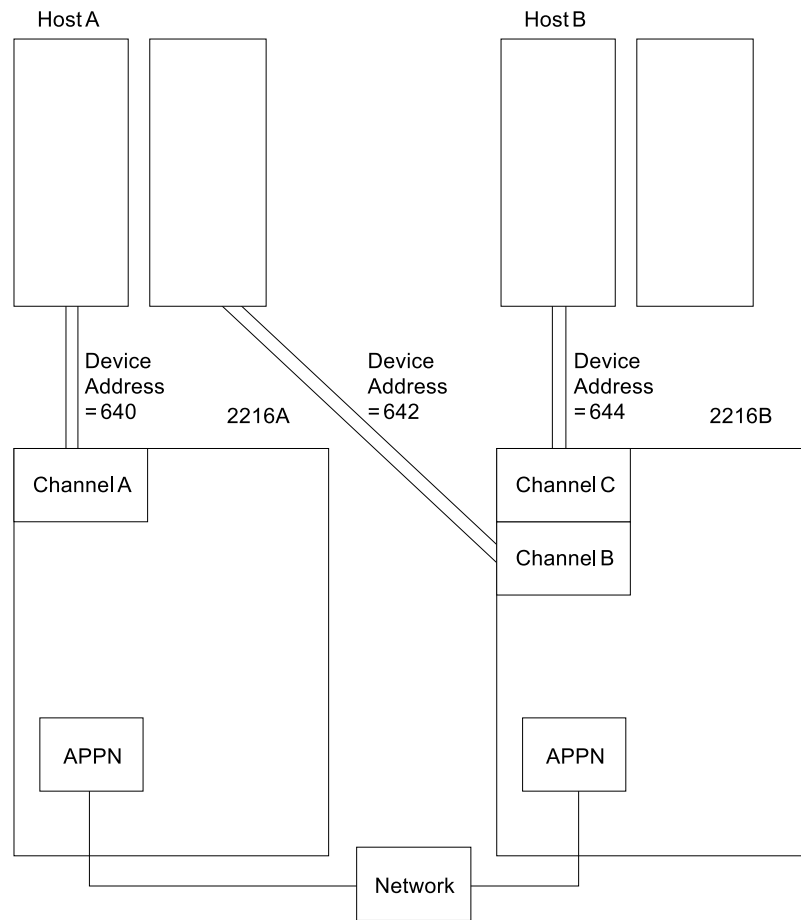
Figure   5-10. 2216 and Host Backup - APPN over Multi-Path Channel+

If one of the 2216s goes down, any HPR traffic should route around that down box. It is a property of APPN HPR to route around the down box. For example, if 2216A goes down, the APPN HPR will path-switch around the down box and any session that was going between host A and the network will now all go though 2216B.

To allow this path switching to occur, you need to make sure that 2216B has an APPN PORT/LINK set up to both host A and host B.

2216 Planning Considerations

This section discusses planning considerations for installing and configuring a 2216. It includes:

- What activities you need to plan for before installing and configuring the 2216 in your network

- What to consider about how the 2216 fits into your network

- What you will need to have available before you begin installation and configuration

- What to consider for supporting the 2216 in the network.

Activities to Plan for Before Installation and Configuration

You will need to plan for the following activities prior to installing and configuring the 2216 in a network:

- Defining the 2216 for channel attachment
- Defining the 2216 for LAN attachment
- Supporting the 2216 in the network.

Defining the 2216 for Channel Attachment: Your system programmer will need to determine configuration and system generation (SYSGEN) parameter values for the following program types at the host:

- Control programs and operating systems (including IOCP, HCD for MVS, MVS, and VM)

- Host programs (including VTAM, TCP/IP, and HPDT for UDP)

- Applications

- Network management (including SNA management services and NetView).

The system generations and configurations should be done before the 2216 hardware is installed and released for customer use. "Host Definition Planning" in the *Multiprotocol Access Services Software User's Guide* contains detailed information about host parameter definition for the 2216.

Defining the 2216 for LAN Attachment: Defining the 2216 for LAN attachment requires several tasks:

- LAN adapter address administration
- Changes to LAN device configurations to optimize performance
- Matching 2216 configuration parameters to those of your LAN or host devices.

Supporting the 2216 in the Network

- Determining 2216 problem reporting and resolution procedures
- Updating procedures, instructions, and network documentation
- Defining requirements for 2216 reconfiguration.

Considerations for Including the 2216 in a Network

Host and LAN planners and administrators will need to be involved in integrating the 2216 into your network. System and application programmers will also participate in defining configuration parameters and installing code.

Configuration Considerations: Before configuring the 2216 in your network, consider:

Addresses Group, functional, multicast, and node (universally or locally administered individual) addresses need to be assigned by the network administrator for each 2216 LAN adapter. These addresses may need to be specified in the configurations for LAN devices that will access a 2216.

SAPs For VTAM communication, the network administrator needs to decide the SAPs to be used for each 2216 LAN adapter.

Each VTAM host program that uses a 2216 LAN adapter is assigned a different SAP value. The SAP for each adapter can be used once on the adapter; VTAM can use the same SAP on different LAN adapters.

Note: If APPN and LSA are configured to use the same LAN adapter, they must use different SAPs.

The network administrator and system programmer must determine how to change the SAP value used by each LAN adapter, if necessary.

MPC+ Timers

Reply TO Timer
This is the amount of time that the MPC+ Group will wait to hear from across the channel during XID2 and DISC exchanges before it decides that the other end of the channel is not answering and this side should continue with the bring-up or bring-down of the MPC+ group.

Sequencing Interval timer
Used to determine whether connection-oriented data is flowing smoothly across the connection on an MPC+ Group. The MPC+ control flows and the APPN activation/deactivation flows flow connection-oriented. Because these commands must have guaranteed delivery at the link level they flow connection-oriented and the Sequencing Interval timer is used to determine whether enough time has passed that checking of the delivery of connection-oriented traffic should be done.

Notes:

1. This value can be overwritten for each APPN PORT on an MPC+ Group. This is done during the APPN PORT configuration.

2. Neither TCP/IP nor HPDT for UDP will flow connection-oriented traffic.

LLC Timers If a 2216 supports remote SNA connections (using a remote bridge, for example), consider what values are needed for LLC timers T1, Ti, and T2 on the LAN adapters.

LAN Number   This number distinguishes between multiple network interfaces of the same type within one 2216. Link number for TCP/IP and ADAPNO for VTAM specify the LAN number to the host program. These definitions must be the same if both programs use the same network interface.

Subchannels   The subchannels (logical paths for ESCON) must be defined for all 2216 LAN/WAN gateway definitions to associate 2216 channel adapters with 2216 LAN adapters.

PMF Password

The Parameter Management Frames (PMF) password protects the station from an unauthorized setting of MIB attributes by a remote station using Simple Mail Transfer Protocol (SMTP) PMF frames.

LAN Data Transfer Rate

The 2216 Token-Ring Adapter can be configured to transfer data at 4 Mbps or 16 Mbps. Select the data transfer rate to match your LAN.

Receive Mode   Determines which frames will be received by the Ethernet adapter.

Transceiver Type

Identifies the type of transceiver that the Ethernet adapter uses.

Optimizing Performance

There are many parameters that affect the overall performance of a host-to-LAN network. The parameters that affect 2216 throughput are discussed in this section.

In planning the volume and flow of traffic over the network, consider the following configuration parameters. It is recommended that the default 2216 host parameters be used initially. You can then tune the network to optimize overall performance.

TCP/IP Window Size

A larger TCP/IP window size allows more frames to be sent before requiring acknowledgement. This helps move frames through devices faster and requires less frequent processing of acknowledgements.

VTAM I/O Buffer Size

Frames are segmented into more than one buffer when the frame size exceeds the VTAM I/O buffer size, causing additional processing overhead. Make the VTAM buffers large enough to contain the largest average frame size.

Also consider the following concepts:

Sharing Subchannels

When defining a LAN/WAN gateway, dedicate a subchannel or subchannel pair for each network interface to ensure maximum performance.

Trace   Using the 2216 trace function may affect performance noticeably.

Frame Size   Most protocols segment data into packets based on restrictions of the network to which they are attached. Bridges, for example, may restrict the size of forwarded frames to the smaller of the two maximum sizes that can be handled by the LANs they connect. Frames that traverse different LAN types can be limited in size by the maximum frame size of the most

restrictive LAN. Frames that are larger than the specified maximum size can get segmented into two or more packets for network transmission; the packets must be reassembled by the receiver into their original size. Some programs and devices discard frames that are too large or too small.

Protocols and applications take these frame size limits into consideration when they determine their maximum frame size; some can negotiate to the largest common frame size that both sender and receiver can handle. (The 2216 does not negotiate frame size.) To reduce the effects of segmenting data into smaller frame sizes, you need to be aware of how devices on the network affect protocol packet size.

Table 5-3 shows the size of the largest frame that can be transferred by each type of 2216 LAN adapter.

Table   5-3. LAN Adapter Maximum Frame Sizes and Channel Adapter Maximum Block Sizes

Adapter Type	Largest Frame Size	Maximum Block Size
Token-Ring (4 Mbps)	4.5 KB	
Token-Ring (16 Mbps)	17.5 KB	
Ethernet V2/IEEE 802.3	1.5 KB	
ESCON		32 KB
FDDI	4.5 KB	

ESCON-Related Publications

Other publications that might be useful to you include:

- *IBM ES/9000, IBM ES/3090 Input/Output Configuration Program User's Guide and ESCON Channel to Channel Reference Volume A04*, GC38-0097†
- *Maintenance Information for Enterprise Systems Connection Links*, SY27-2597†
- *IBM I/O Configuration Program User's Guide and Reference* (308x processors), GC28-1027†
- *Fiber Optic Link Planning*, GA23-0367

Materials available for Virtual Telecommunications Access Method (VTAM) Version 4.4

- *VTAM V4R4 Network Implementation Guide*, SC31-8370
- *VTAM V4R4 Resource Definition Reference*, SC31-8377

Materials available for the IBM Transmission Control Protocol/Internet Protocol for VM (TCP/IP for VM) program and for Multiple Virtual Storage (TCP/IP for MVS) program

- *IBM TCP/IP V2R4 for VM: Planning and Customization*, SC31-6082†
- *IBM TCP/IP V2R2 for VM: Installation and Interoperability*, GG24-3624†
- *TCP/IP V3R2 for MVS: Planning and Migration Guide*, SC31-7189-02†
- *OS/390 TCP/IP Update Guide*, GC31-8553

For TCP/IP support over MPC, see the *IBM OS/390 TCP/IP OpenEdition Planning & Release Guide*, SC31-8303

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† You can get this publication from your IBM representative or your local IBM branch office. Ask your IBM representative for information on purchasing other manuals or kits.

Appendix A. Charts and Worksheets

This appendix contains a number of planning worksheets that will help you to get your IBM 2216 operational and ready to perform any necessary configuration. The worksheets are:

- Rack Inventory Chart (page A-3)

- Quick Configuration Worksheet (page A-4)

- Initial Configuration Worksheet (page A-9)

These charts and worksheets are useful in helping the network installer complete the installation. They should be completed by the network planner or network administrator.

You are authorized to make as many copies of these charts and worksheets as you need to plan your network. Save the blank originals for future copies.

Hardware Configuration Quick Reference

This fanfold card (GX27-3988) is shipped separately with each IBM 2216. Part of the setup procedure (in the *Installation and Initial Configuration Guide*) is to fill out this card, which when completed will describe how your 2216 is configured and cabled.

The *IBM 2216 Hardware Configuration Quick Reference* card is an ongoing record of the connections made to the 2216 port receptacles. In addition, the chart records the location of the 2216 and the number of the ring or segment to which it attaches. The card is used during installation and cabling of the 2216 and while performing problem determination procedures.

The Rack Inventory Chart

The Rack Inventory Chart (on page A-3) allows you to keep track of all components installed in each rack in your site to facilitate planning and installation.

Fill out a Rack Inventory Chart for each of the racks where you will be installing 2216s. Mark the location of each 2216 on the chart using the scaled template provided. Write the unit number and device type of each component directly on the chart.

Give the completed chart to the person who will install the 2216 in your network.

A-1

Initial Configuration Worksheet

Make one copy of page A-9 for each device you will be adding.

You must be at the `Config (only)>` prompt to perform initial configuration on the 2216. You must add each device (port) that you will be using.

The syntax for the **add** command is as follows:

    Config (only)> **Add Device Token-Ring 1 1**

The example above of the **Add Device** command applies to adding an interface on a multi-port adapter. If you add an interface on a single-port adapter, then you merely provide the slot number. If you add a dial circuit device, then you enter **add device dial-circuit**. See the *Multiprotocol Access Services Software User's Guide*.

Quick Configuration Worksheet

Use Quick Configuration to configure bridging and protocols for the devices. You can access Quick Configuration by typing **QC** at the `Config (only)>` prompt. Use the Quick configuration worksheets to help you complete the configuration.

Rack Inventory Chart for the 2216

Date

Wiring Closet Number		Rack Number		Planner's Initials	

Rack Diagram
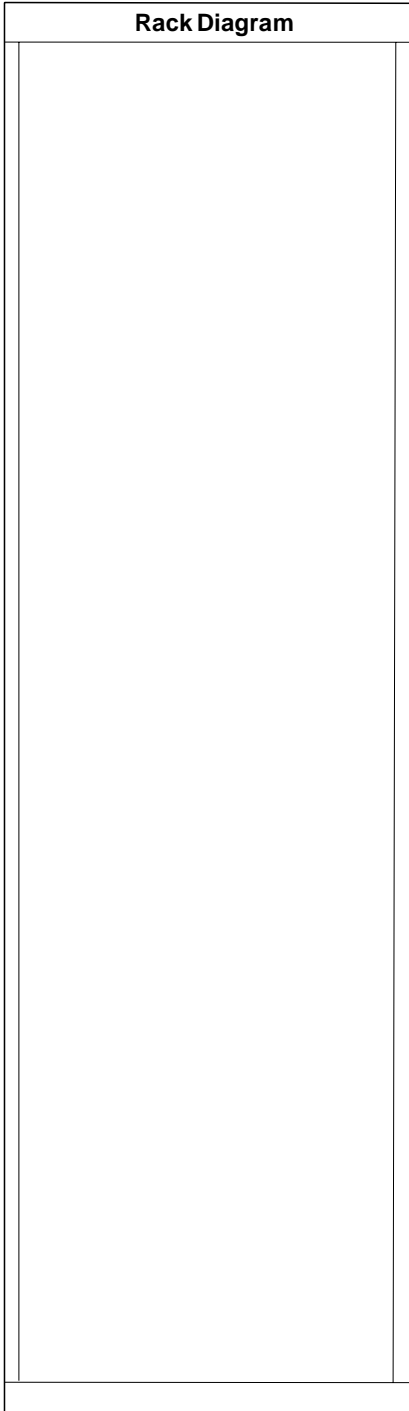
Instructions

Fill out a Rack Inventory Chart for each equipment rack.

1. Enter the wiring closet location number, the equipment rack identification number, and the planner's initials.

2. Use the dimensions below to represent the size of the 2216.

3. Write the unit identification number and component type on each component on the chart.

480 mm (18.9 in.)

13U
572 mm
(22.5 in)
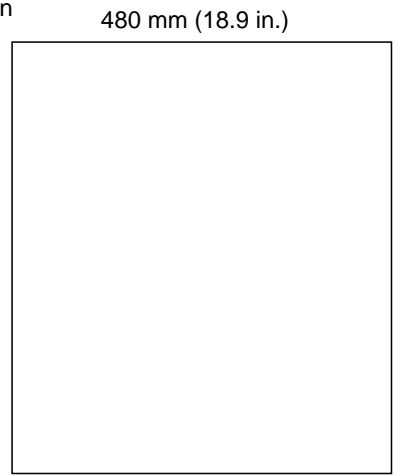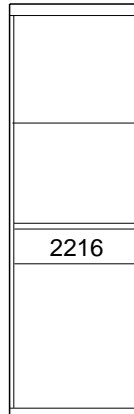
2216 Dimensions Scaled to the size of the Rack Diagram

Example

2216

Quick Configuration Worksheet

Completed by: _____   Date: _____

IBM 2216 Name: _____

Adapter Type?	□ Token-Ring	□ Ethernet	□ Other _____
Port (Interface) Number	_____		

LAN Emulation			
Configure **LAN Emulation**?	□ YES	□ NO	
Configure LECS to direct clients requesting unspecified ELAN type to:	□ Token-Ring	□ Ethernet	□ Other _____
Do you want to add an emulated Token Ring?	□ YES	□ NO	
Enter the ELAN Name: _____			
Enter the selector: (2 - FF):	□ 2 †	□ Other _____	
Do you want to enable Broadcast Manger for IP?	□ YES	□ NO	
Do you want to enable Broadcast Manger for IPX?	□ YES	□ NO	
Do you want to enable Broadcast Manger for NetBIOS?	□ YES	□ NO	
Do you want to enable Broadcast Manger for Source Routing?	□ YES	□ NO	
Do you want to add an emulated Ethernet?	□ YES	□ NO	
Enter the ELAN Name: _____			
Enter the selector: (2 - FF):	□ 3 †	□ Other _____	
Do you want to enable Broadcast Manger for IP?	□ YES	□ NO	
Do you want to enable Broadcast Manger for IPX?	□ YES	□ NO	
Do you want to enable Broadcast Manger for NetBIOS?	□ YES	□ NO	

Bridging

Configure **LAN Emulation**?	□ YES	□ NO
Configure SRT Bridging?	□ YES	□ NO
Bridge No. (*0–F*)	□ A †	□ Other
		_____
Configure Interface ___ (*0–xx*)?	□ YES	□ NO
Configure Source Routing on this interface?	□ YES	□ NO
Segment No. (*1–FFF*)	□ A †	□ Other
		_____
Save this configuration?	□ YES	□ NO

Protocols

Configure **Protocols**?	□ YES	□ NO

IP

Configure IP?	□ YES	□ NO
Configure Interface ___ (*0–xx*)?	□ YES	□ NO
Configure IP on this interface?	□ YES	□ NO
IP address		Address
	_____	Mask _____
Enable Dynamic Routing?	□ YES	□ NO
Enable OSPF?	□ YES	□ NO
Configure community with Write_Read_Trap Access?	□ YES	□ NO
Community Name		
	_____	
Save this configuration?	□ YES	□ NO

IPX		
Configure **IPX**?	☐ YES	☐ NO
Configure Interface ___ (*0–xx*)?	☐ YES	☐ NO
Configure IPX on this interface?	☐ YES	☐ NO

Token Ring encapsulation (*frame*) type?

    ☐ TOKEN—RING MSB [†]

    ☐ TOKEN—RING LSB

    ☐ TOKEN—RING_SNAP MSB

    ☐ TOKEN—RING_SNAP LSB

Ethernet encapsulation (*frame*) type?

    ETHERNET_8022

    ETHERNET_8023

    ETHERNET_II

    ETHERNET_SNAP

FDDI encapsulation (*frame*) type?

    ☐ FDDI

    ☐ FDDI_SNAP) [†]

Network No. (*1–FFFFFFFD*)

    _____

Enable IPXWAN?	☐ YES	☐ NO

Host No. for Serial Lines

    _____

Configure IPXWAN Nodeid?	☐ YES	☐ NO
Nodeid (*1–FFFFFFFD*)	☐ 1 [†]	☐ Other

    _____

Save this configuration?	☐ YES	☐ NO

DNA (DECnet)				
Configure **DNA**?	□ YES	□ NO		
Highest Node No. (*1–1023*)	□ 32 †	□ Other _____		
Router Level	□ Level1 †	□ Level2	□ DEC Level1	□ DEC Level2
Highest Area (*1–63*)	□ 63 †	□ Other _____		
Node address _____		Address Mask _____		
Configure DNA on Interface ___?	□ YES	□ NO		
Max Routers (*1–33*)?	□ 16 †	□ Other _____		
Save this configuration?	□ YES	□ NO		

Note: † = default

Initial Configuration Worksheet

Table   A-1. Initial Configuration Worksheet

☐ Add	☐ Device	☐ Token-Ring	Slot #: _____ Port #: _____
		☐ Ethernet	Slot #: _____ Port #: _____
		☐ ATM	Slot #: _____
		☐ ESCON	Slot #: _____
		☐ 10/100 Mbps Ethernet	Slot #: _____
		☐ FDDI	Slot #: _____
		☐ HSSI	Slot #: _____
		☐ ISDN (T1/J1)	Slot #: _____
		☐ ISDN (E1)	Slot #: _____
		☐ X.21	Slot #: _____ Port #: _____
		☐ V.35/V.36	Slot #: _____ Port #: _____
		☐ EIA-232E/V.24	Slot #: _____ Port #: _____
		☐ Dial Circuits	

Appendix B. Cable Pin Assignments

This appendix describes the signals associated with the pins on the cable connectors for the service port and the WANs supported by the 2216 for customer-unique applications.

LAN and ISDN ports use industry-standard cables. Contact your cable supplier for more information.

Disclaimer

The information in this chapter does not guarantee function or compliance with radio frequency interference (RFI) or electromagnetic interference (EMI) regulations.

Service Port

The service port provides an EIA 232/V.24-compatible DTE interface on a 9-pin male D-connector with the following signal definitions:

Table   B-1. Service Port Signal Definitions

Pin No.	Signal	Driven by 2216	Received by 2216
1	Carrier Detect		x
2	Receive Data		x
3	Transmit Data	x	
4	Data Terminal Ready	x	
5	Ground		
6	Data Set Ready		x
7	Request To Send	x	
8	Clear To Send		x
9	Ring Indicate		x

A null modem adapter, supplied with the IBM 2216, is required for attachment to a terminal having a male connector.

Wide Area Networks (WANs)

The cables that IBM ships for the IBM 2216 are described in this section.

If you need special cables with specific lengths, use the information in this section to specify the assignment for the pins. The following list gives the conformity for the EIA and CCITT connectors:

* EIA 232-D/CCITT V.24 connector must conform to ISO 2110.2
* CCITT V.35 connector must conform to ISO 2593
* CCITT V.36 connector must conform to ISO 4902
* CCITT X.21 connector must conform to ISO 4903

Bulk cable consists of the appropriate numbers of 28 American Wire Gauge (AWG) tin-plated copper individually-shielded pairs, with an overall shield. The nominal

characteristic impedance of the bulk cable should be 85 ohms. The cable should meet the safety requirements of the appropriate local safety organization.

The length of the connection from the 2216 to the attaching equipment should not exceed 15 m (50 ft).

The wiring of these cables is shown in the following tables.

EIA 232-E/V.24 (FC 2705 and 2706)

Table   B-2. EIA 232/V.24 Connector Pin Assignments, 25-pin D, Male, Modem-Attach

Signal	Machine End Pin Number	DCE End Pin Number
Protective Ground	1	1
Transmitted Data	2	2
Signal Ground	7	7
Received Data	3	3
Data Set Ready	6	6
DCE Transmitter Signal Element Timing	15	15
Receiver Signal Element Timing	17	17
Clear To Send	5	5
Local Loopback	18	18
Ring Indicate	22	22
Data Terminal Ready	20	20
Request To Send	4	4
Received Line Signal Element	24	8
DTE Transmitter Signal Element Timing	24	24
Data Signal Rate Selector	23	23

Table   B-3. EIA 232/V.24 Connector Pin Assignments, 25-pin, D, Female, Direct-Attach

Signal	Machine End Pin Number	DTE End Pin Number	Signal
Send Data	2	3	Received Data
Signal Ground	7	7	Signal Ground
Received Data	3	2	Transmitted Data
Data Set Ready	6	20	Data Terminal Ready
Transmit Clock	15	24	DTE Transmitter Signal Element Timing
Receive Clock	17	24	Receiver Signal Element Timing
Clear To Send	5	8	Received Line Signal Detect
Data Terminal Ready	20	6	Data Set Ready
Request To Send	4	8	Received Line Signal Detect
Received Line Signal Detect	8	5	Clear to Send
Received Line Signal Detect	8	4	Request to Send
DTE Transmitter Signal Element Timing	24	15 17	DCE Transmitter Signal Element Timing Receiver Signal Element Timing

V.35 (FC 2707 and 2708)

Table B-4. V.35 Connector Pin Assignments, 34-pin Block, Male, Modem-Attach

Signal	Machine End 25-Pin Connector Pin Number	DCE End Pin Number
Transmitted Data (A)	2	P
Transmitted Data (B)	14	S
Received Data (A)	3	R
Received Data (B)	16	T
Receive Timing (A)	17	V
Receive Timing (B)	9	X
Transmit Timing (A)	15	Y
Transmit Timing (B)	12	AA
Terminal Timing (A)	24	U
Terminal Timing (B)	11	W
Signal Ground	7	B
Request To Send	4	C
Clear to Send	5	D
Receive Line Signal Detect	8	F
Data Terminal Ready	20	H
Data Set Ready	6	E

Table   B-5.   V.35 Connector Pin Assignments, 34-pin Block, Female, Direct-Attach

Signal	Machine End 25-Pin Connector Pin Number	Machine End Pin Number	Signal
Transmit Data (A)	2	R	Receive Data (A)
Transmit Data (B)	14	T	Receive Data (B)
Receive Data (A)	3	P	Transmit Data (A)
Receive Data (B)	16	S	Transmit Data (B)
Shield	1	A	Shield
Signal Ground	7	B	Signal Ground
Receive Line Signal Detect	8	C	Request to Send
Receive Line Signal Detect	8	D	Clear to Send
Request to Send	4	F	Receive Line Signal Detect
Clear to Send	5	F	Receive Line Signal Detect
Data Set Ready	6	E	Data Set Ready
Data Terminal Ready	20	E	Data Set Ready
Transmit Clock In (A)	15	U	Terminal Timing (A)
Receive Clock In (A)	15	U	Terminal Timing (A)
Receive Clock In (B)	17	U	Terminal Timing (A)
Transmit Clock In (B)	12	W.	Terminal Timing (B)
Terminal Timing (A)	24	Y	Transmit Clock In (A)
Terminal Timing (A)	24	V	Receive Clock In (A)
Terminal Timing (B)	11	X	Receive Clock In (B)
Terminal Timing (B)	11	AA	Transmit Clock In (B)

V.36 (FC 2709 and 2710)

Table B-6. V.36 Connector Pin Assignments, 37-pin D, Female to Female, Modem-Attach

Signal	Machine End Pin Number	DCE End Pin Number	
Transmit Data (A)	4	6	Receive Data (A)
Transmit Data (B)	22	24	Receive Data (B)
Receive Data (A)	6	4	Transmit Data (A)
Receive Data B)	24	22	Transmit Data (B)
Transmit Clock out (A)	17	5	Transmit Clock in (A)
		8	Receive Clock in (A)
Transmit Clock out (B)	35	23	Transmit Clock in (B)
		26	Receive Clock in (B)
Transmit Clock in (A)	5	17	Transmit Clock out (A)
Receive Clock in (A)	8		
Transmit Clock in (B)	23	35	Transmit Clock out (B)
Receive Clock in (B)	26		
Data Set Ready	11	11	Data Set Ready
Data Terminal Ready	12		
Receive Line Signal Detect	13	7	Request to Send
		9	Clear to Send
Request to Send	7	13	Receive Line Signal Detect
Clear to Send	9		
Signal Ground	19	19	Signal Ground
DCE Signal Ground	20	37	DTE Signal Ground
DTE Signal Ground	37	20	DCE Signal Ground

Table   B-7. V.36 Connector Pin Assignments, 37-pin D, Female to Male, Direct-Attach

Signal	Machine End Pin Number	DTE End Pin Number
Transmit Data (A)	4	4
Transmit Data (B)	22	22
Receive Data (A)	6	6
Receive Data B)	24	24
Send Timing (A)	5	5
Send Timing (B)	23	23
Receive Timing (A)	8	8
Receive Timing (B)	26	26
Terminal Timing (A)	17	17
Terminal Timing (B)	35	35
Data Set Ready	11	11
Data Terminal Ready	12	12
Receive Line Signal Detect	13	13
Request to Send	7	7
Clear to Send	9	9
Signal Ground	20	20
Signal Ground	19	19
Signal Ground	37	37

X.21 (FC 2711 and 2712)

Table   B-8. X.21 Connector Pin Assignments, 15-pin D, Male

Signal	Machine End Pin Number	DCE End Pin Number
Transmit (A)	2	2
Transmit (B)	9	9
Control (A)	3	3
Control (B)	10	10
Indicate (A)	5	5
Indicate (B)	12	12
Signal Element Timing (A)	6	6
Signal Element Timing (B)	13	13
DTE Transmit Signal Element Timing (A)	7	
DTE Transmit Signal Element Timing (B)	14	14
Signal Ground	8	8

Table   B-9. X.21 Connector Pin Assignments, 26-pin D, Male to 15-pin Female

Signal	26-pin Connector	15-pin Connector	Signal
Signal Ground	8	8	Signal Ground
Transmit (A)	2	4	Receive (A)
Transmit (B)	9	11	Receive (B)
Receive (A)	4	2	Transmit (A)
Transmit Signal Element Timing (A)	7	6	Signal Element Timing (A)
Transmit Signal Element Timing	14	13	Signal Element Timing
Signal Element Timing	1	1	Shield
Jumper	3,5		
Jumper	10,12		
		3,5	Jumper
		10,12	Jumper

HSSI (Not orderable as a FC)

Table B-10. HSSI Connector Pin Assignments, 5-pin Male, Modem-Attach

Signal	Machine End 25-Pin Connector Pin Number	DCE End Pin Number
SG (signal ground)	1 26	1 26
RT (receive timing)	2 27	2 27
CA (DCE available)	3 28	3 28
RD (receive data)	4 29	4 29
LC (loopback circuit c)	5 30	5 30
ST (send timing)	6 31	6 31
SG (signal ground)	7 32	7 32
TA (DTE available)	8 33	8 33
TT (terminal timing)	9 34	9 34
LA (loopback circuit A)	10 35	10 35
SD (send data)	11 36	11 36
LB (loopback circuit B)	12 36	12 36
SG (signal ground)	13 38	13 38
Ancillary to DCE	14 39	14 39
Ancillary to DCE	15 40	15 40
Ancillary to DCE	16 41	16 41
Ancillary to DCE	17 42	17 42
Ancillary to DCE	18 43	18 43
SG (signal ground)	19 44	19 44
Ancillary from DCE	20 45	20 45
Ancillary from DCE	21 46	21 46
Ancillary from DCE	22 47	22 47
Ancillary from DCE	23 48	23 48
Ancillary from DCE	24 49	24 49
SG (signal ground)	25 50	25 50

Table B-11. HSSI, 50-pin Block, Male, Null Modem Cable Pin Assignments

Signal	Machine End 25-Pin Connector Pin Number	Machine End Pin Number	Signal
RT (receive timing)	2 27	9 34	TT (terminal timing)
CA (DCE available)	3 28	8 33	TA (DTE available)
RD (receive data)	4 29	11 36	SD (send data)
LC (loopback C)	5 30	10 35	LA (loopback A)
ST (send timing)	6 31	6 31	ST (send timing)
TA (DTE available)	8 33	8 33	CA (DCE available)
TT (terminal timing)	9 34	2 27	RT (receive timing)
LA (loopback A)	10 35	5 30	LC (loopback C)
SD (send data)	11 36	4 29	RD (receive data)
Ground	1 26	1 26	Ground
Ground	13 38	13 38	Ground
Ground	7 32	7 32	Ground
Ground	19 44	19 44	Ground
Ground	25 50	25 50	Ground
loopback (no conn.)	12 37	12 37	loopback (no conn.)
not used	any not listed	any not listed	not used

Appendix C. Adapter Plugging Defaults

Units assembled at the factory follow the plugging rules that are described in this appendix.

Plugging Sequences

Table C-1 illustrates how the slots are numbered: two rows of four slots, numbered 1 through 8:

Table C-1. Slot Numbering			
Slot 1	Slot 2	Slot 3	Slot 4
Slot 5	Slot 6	Slot 7	Slot 8

The following tables show the default sequence of installation for the various adapters.

- FC 2280 and FC 2281 are installed left to right, beginning with slot 1. A maximum of six can be installed in any single IBM 2216.

Table C-2. FC 2280s (LIC 280s) and FC 2281s (LIC 281s)			
first	third	fifth	
second	fourth	sixth	

- Other adapters are installed right-to-left in the first-available slot beginning with slot 8 on the bottom and far right.

Table C-3. All Other Adapters			
eighth	sixth	fourth	third
seventh	fifth	second	first

Slots and Adapters

There are two large slots, designated *A* and *B*, on the IBM 2216. Slot *A* is unused. Slot *B* is occupied by the system card. In addition, there are eight adapter slots, designated *1* through *8*.

- No more than **six** of any combination of Token-Ring (FC 2280) and Ethernet (FC 2281) adapters can be installed.

- If a combination of **six** 2280 and 2281 adapters is to be installed, no other adapters will be installed.

- If a combination of **five** 2280 and 2281 adapters is to be installed, then two additional adapters can also be installed.

- The IBM 2216 supports a maximum of:
  - **Four** ESCON adapters (FC 2287)
  - **Two** ATM adapters (FC 2284 or FC 2293)
  - **Four** ISDN adapters (FC 2283 or FC 2292)

    Note: You can configure a 2216 with as many high speed adapters (FDDI FC 2286, 10/100-Mbps Ethernet FC 2288, and HSSI FC 2289) as desired; however, you may not be able to achieve full media throughput concurrently on all the adapters. When planning for installation, review system performance expectations with an IBM representative.

Any adapter can be installed in any of the eight adapter slots with the following restrictions:

1 If the 2-port Token-Ring (FC 2280) or 2-port Ethernet (FC 2281) adapter is plugged into slot 3 and active, then slot 4 cannot be used.

2 If the 2-port Token-Ring (FC 2280) or 2-port Ethernet (FC 2281) is plugged into slot 4 and active, then slot 3 cannot be used.

3 If the 2-port Token-Ring (FC 2280) or 2-port Ethernet (FC 2281) adapter is plugged into slot 7 and active, then slot 8 cannot be used.

4 If the 2-port Token-Ring (FC 2280) or 2-port Ethernet (FC 2281) adapter is plugged into slot 8 and active, then slot 7 cannot be used.

Appendix D. Management of Routing Networks

Experience has shown that networks employing routing have certain characteristics and requirements in common. The information in this appendix has been gathered over time through experience with such networks and is offered as a general guide to their management.

This appendix describes the management of routing networks and covers the following topics:

- Network characteristics
- Basic principles
- The network organization
- Configuration management
- Router changes (configuration and hardware)
- Network changes

Network Characteristics

The routing network includes many components and has the following characteristics:

- The network is an open system.
- There are many similar but different components.
- Each configuration file must complement many others.
- Many different approaches can be used.
- Each configuration file contains many parameters (1300+ available).
- Many failures are dependent on specific application loads.
- Some configuration errors appear to be box problems.
- One configuration error can bring down the network.

The network is a complex system that must be managed. There are:

- Many interdependencies
- Few absolutes

Basic Principles

Configuration Control

Configuration control requires a consistent approach that is best achieved by one person, referred to in this appendix as the *Network Engineer*, or by a unified team. This person or team should work in conjunction with a central control point, referred to as the *Network Management Center (NMC)*.

The Network Engineer
To ensure consistency throughout the network, a single individual or a unified team must establish an approach and define or approve the configuration for each network box. Routing networks are defined by a large number of parameters specified in a number of different network boxes. The parameters specified in the different boxes must complement each other to form a unified and functioning network. The configuration program specifies these network parameters for the IBM 2216.

There is no "right" set of parameters and box configurations for a network. There are many possible configuration combinations.

Central Control Point (Network Management Center)

All configurations and updates should be loaded and updated from a central control point, usually the Network Management Center (NMC). This allows a single individual (or team) to monitor, test, and coordinate activities at several locations or sites from a single location. This is easily accomplished using TCP/IP Telnet methods in combination with the remote access features in the IBM routers.

An exception to loading all configurations directly from a central control point is the initial configuration for a new router or the reconnection of a router to the network following a repair or hardware change. However, all these configurations should be supplied by, and controlled by, the NMC.

When problems occur, all activities should be coordinated with the Network Management Center. The NMC involves the Network Support Team, network engineer, and box support/service organizations as needed.

Step-by-Step Configurations

Maintain a solid base by configuring the network step-by-step. The key factors are:

- IP connectivity (direct routes only)
- One protocol at a time
- Patience

IP Connectivity

Each router should be configured initially with only IP direct routes. With this configuration installed, it is easy to verify that each port on the router is connected to the device specified. Simply "ping" through the port to the attached device. If the ping is not successful, it is clear that the link being pinged has a problem. If dynamic routing protocols are active, they may route the ping around the problem, making it difficult to detect and identify the problem.

One Protocol at a Time

After IP connectivity has been established, enable one protocol at a time and test each to verify the router is functioning in the network as expected. This step-by-step approach applies to application protocols such as IPX and NetBIOS as well as network protocols such as OSPF and RIP.

In established well-controlled networks where step-by-step configurations have been applied consistently without corrections, you can combine several protocols into one step. However, if you encounter problems, return to a single protocol per step until consistency is reestablished.

Patience

It may take considerable time for some configurations to load and become functional, especially if the advanced network protocols such as OSPF are used in a large network. For large networks with thousands of devices, it is not unusual for this to take from 15 minutes to an hour or more.

Configuration and Network Debugging

Reestablishes a solid base:

- Expect many types of errors.
- Limit time attempting a "quick fix."
- Generate new configurations from scratch.

Many Types of Errors

Errors in the configuration program can cause many different types of problems. They may initially appear to be router hardware problems because the router will not complete booting or data will not flow through an adapter port. Also, configuration errors may not cause a problem initially, but will cause a problem when specific conditions are encountered.

Generate New Configurations

If a problem is not resolved after you make a few changes to a configuration file, it is highly recommended that you generate a new configuration file from scratch following the step-by-step approach already defined.

A few changes to the configuration will often create additional errors which compounds the problem and requires a number of hours to debug and resolve. Also, some parameters may have been activated or changed by accident. It may take over an hour to check all 1300+ parameters in the questionable configuration file. A new configuration can usually be generated and tested step-by-step within an hour. Also, there is a high probability that this new configuration will function as desired or a defect in the network configuration or the network devices will be identified.

The Network Organization

The key is to have structure and control. A typical organization consists of:

- The Network Management Center (NMC)
- The Network Engineer
- The Network Support Team
- The Network Manager

Note: Many other structures can be used, and these functions can be combined with others.

Network Management Center

The Network Management Center (NMC) provides network monitoring, network coordination, and network control.

Network Monitoring

For large networks, the NMC:

- Provides support 24 hours a day, 7 days a week, with operators present. This may be combined with the Help Desk.

- Uses NV/6000 or a similar tool.

- Monitors network capacity measurements.

- Takes all calls relative to network problems.

- Maintains network diagram and associated databases.
- Maintains data and service procedures for:
    - Network external connections (T1, Frame Relay, and so on)
    - Equipment used in the network
    - Service and support organizations

For small networks, the NMC:

- Provides support 24 hours a day, 7 days a week. This function may be combined with the Network Engineer function.
- Takes or records all calls relative to network problems.
- Maintains network diagram and associated data.
- Maintains data and service procedures as needed.

Network Coordination
The NMC:

- Calls and dispatches the Network Support Team to investigate problems. The Network Engineer or IBM systems engineering operations specialist may replace the Support Team for small networks.
- Calls suppliers and others for problem resolution.
- Negotiates network down time between network users and the problem solvers or network changers.
- Coordinates and schedules planned network down time and maintenance.
- Coordinates requests for network improvements and expansions. This activity includes:
    - Receiving requests from users and management
    - Forwarding requests to the Network Engineer
    - Informing users and requesters of planned actions
- Schedules and coordinates network changes as defined by the Network Engineer.

Network Control
The NMC:

- Implements and documents all changes to the network. The Network Support Team or Network Engineer make the changes, but the NMC controls and documents them.
- Coordinates all maintenance, test, and diagnostics activities:
    - Before activity starts
    - After activity is complete, with results reported even if previously scheduled and on-time
- Ensures that network procedures are followed ... "network police."
    - For problem determination, maintenance, and changes
    - Procedures provided by the Network Engineer

      Note: The Network Engineer must also follow the procedures.
- Escalates issues to the correct person:
    - Users to area coordinator or area management

- Service providers to their management
- Network support team to the Network Engineer
- Network Engineer to the Network Manager

Network Engineer

The Network Engineer:

- May be replaced by a team of people that functions as single unit
- May be the IBM systems engineering operations specialist for small networks
- Obtains recommendations from many sources.

The Network Engineer is responsible for:

1. Network design, function, and cost:

   - Defines or approves all network changes
   - Tracks and analyzes network performance and issues
   - Defines NMC and other procedures associated with the network

2. Network problem resolution:

   - Resolves problems reported by the NMC, management, or network users
   - Coordinates all activity through the NMC

3. Training and education:

   - NMC personnel
   - Network support team personnel
   - Network users
   - Managers, both users and network support
   - Service and other related personnel
   - New network engineers

   Note: Other agencies may actually deliver the training.

Network Support Team

The Network Support Team is responsible for:

1. Network maintenance and debugging:

   - Box connectivity and interface connectors, converters, and adapters
   - Workstations, servers, terminals, printers
   - Bridges, routers
   - Facilities, space, and security as required for each item.
   - Location and access to each box, cable, and set of documentation.

2. Identification and correction of problems or concerns:

   - Resolves issues directly when possible
   - Requests support from component or box supplier when needed
   - Provides Network Engineer or others with data relative to the problem or concern
   - Implements tests or corrections as defined by Network Engineer or equipment supplier
   - Keeps NMC informed of all activities and results

3. Assistance and coordination of equipment suppliers:

4. Implementation of measurements, tests, and changes according to directions provided by the Network Engineer.

Network Manager

The Network Manager is responsible for:

1. Network management and operation:

   - Sets priorities
   - Resolves disputes
   - Ensures quality

2. Finances:

   - Funding
   - Expense Recovery

3. Staffing:

   - Obtains the skills needed
   - Deals with personnel issues and evaluations
   - Responsible for organization and controls

4. Interfacing to the organization and users:

   - Ensures continued funding
   - Identifies changes in requirements

5. Supporting the "network police"

Configuration Management

Configuration management involves:

- Configurations
- Configuration sets
- Naming conventions
- Router configuration changes
- Hardware changes that affect the network
- Hardware changes that do not affect the network
- Router code updates

Configurations

These are maintained:

1. On the Configuration Workstation in the NMC for each router:

   - An IP direct route only configuration to verify router connectively
   - A complete protocol configuration based on current functions
   - Individual protocol test configurations
   - A history of previous configurations

   Different configuration files must be clearly labeled or named.

2. At each router:

   - PC terminal emulator and IP direct route diskettes

     or
   - Data and instructions for configuring an IP direct route plus ASCII terminal, cables, and so on.

   Alternatively, a telephone line and modem can be connected to a service port and the NMC can install configuration files as needed.

3. On additional configuration workstations or files:

  - Backup files are needed for NMC configuration workstation
  - Multi-configuration workstations may be needed for large or geographically dispersed networks, but must be closely coordinated and controlled.

Configuration Sets

Configuration sets are maintained in configuration database (CDB) files created by configuration programs.

Different configuration sets can be maintained for:

  - Current network operations (production)
  - Previously-used CDBs
  - Special applications or events
  - Tests for special functions, performance, and so on
  - Planned improvements and expansions

Naming Conventions

Concepts

Name each configuration file so that it can be quickly and directly identified relative to:

  - Router
  - Configuration type (IP only, IP routing protocols, and so on)
  - Configuration set

A naming convention may be required to use special programs for configuration set transfer and import.

Configuration Database Names

The following example is an approach used for AIX workstations. It uses an 8-character name with the following format:

```
xxxxxxxx.CDB
```

Examples:

`CURPROD_.CDB`   Current production configuration set

`CURIPDIR.CDB`   Current IP Direct Route configuration set

`H930814_.CDB`   History production configuration from 8/14/93

`E1103TST.CDB`   Enhancement configuration set tested 11/03

`BLDAPPN_.CDB`   Building configuration set for APPN.

Configuration File Names

An approach used for AIX workstations:

```
xxxxxxxx-Rrrrrlllbbbb-nnnnnn
   |      |  |   |     |
   8    1 4  7 1 6              27 Characters Displayed
   |      |  |   |
   |      |  |    ------ Application Information
   |      |   ---------- Location & Building
   |       ------------ Router Number
    --------------Configuration Set Name
```

Examples of CDB files:

```
CURPROD_-R0023ALT0063-ENG
CURPROD_-R0102NYC953K-ACTPAY
CURPROD_-R1031RAL016A-DIVHQ
CURPROD_-R0527TKO_ASC-MFG001
```

⋮

```
CURIPDIR-R0023ALT0063-ENG
CURIPDIR-R0102NYC953K-ACTPAY
CURIPDIR-R1031RAL016A-DIVHQ
CURIPDIR-R0527TKO_ASC-MFG001
```

Examples of router directory *(names)*

```
CURPROD_-R0023ALT0063-ENG
CURIPDIR-R0023ALT0063-ENG
H930814_-R0023ALT0063-ENG
E1103TST-R0023ALT0063-ENG
BLDAPPN_-R0023ALT0063-ENG
```

Router Configuration Changes

Router configuration changes include:

- Adjustment of cost factors, filters, etc.
- Adjustment of data collection or tracking
- Addition of protocol features
- Adjustment for a network addition

Make configuration changes as follows:

1. The Network Engineer defines or approves all changes, specifying the time and/or prerequisites for implementation:

   - Schedule for non-critical or off-shift periods
   - Stable network defined as no problems within xx hours

2. All changes include a description of:

   - The expected events during the configuration change
   - The expected results or impact on the router and network

3. All changes include a "bail-out" plan:

   - How to keep the network operational if problems develop
   - When to implement the plan

4. The NMC applies configuration changes:

   - Established procedures are followed.
   - Changes and results are documented.

- Network engineer and others may observe or assist.

Note: If problems are encountered, obtain assistance from:

- The Network Support Specialist
- The Network Engineer
- The IBM 2216 Level II Support

Changes to a Router

Changes to a router include hardware changes that do or do not affect the network, and router code updates.

Hardware Changes that Affect the Network

These changes include:

- Adapter, port, or interface cable changes
- Connection of a new router into the network
- System board replacement

Make hardware changes that affect the network as follows:

1. The Network Engineer defines or approves all network changes, including:

   - Change instructions
   - Time and prerequisites for changes
   - Results and impact of changes
   - A "bail-out" plan, and when to implement it

2. The NMC schedules all changes to the network.

3. The service representative contacts the NMC and verifies planned activities, including the "bail-out" plan.

4. The service representative implements the hardware changes and runs diagnostics as needed.

5. The NMC and service representative verify that:

   - Cables are connected to the ports according to the configuration.
   - The operating system level and Configuration Program are compatible.

6. The service representative connects the router to the network by configuring an IP direct route to the network using the instructions and data provided.

7. The NMC completes the IP direct route configuration.

8. The NMC verifies network connectivity by testing connectivity to and from each attached port using the network diagram and change instructions.

9. The NMC installs IP routing protocol configurations and verifies them.

   Note: The service representative may leave the site at this point.

10. The NMC installs application protocol configurations and verifies them.

11. The NMC documents the changes and their impact, and monitors function for a significant time.

Hardware Changes that Do Not Affect the Network

These changes include, for example, replacement of a fan or power supply in a router that was functioning in the network prior to the hardware problem. Hardware changes that do not affect the network are made as follows:

1. The NMC schedules all changes to the network.

2. The service representative contacts the NMC and verifies planned activities:

   - "Bail-out" plan
   - Availability of hardware and configuration files

3. The service representative implements the hardware changes and runs diagnostics as needed.

4. The service representative informs the NMC that the router is ready for network reconnection.

5. The service representative connects the router to the network by plugging in the power cord and verifying that the system and ports are active without errors.

6. The NMC verifies that the router is functioning as before.

7. The NMC documents the changes.

Router Code Updates

Update the router code as follows:

1. The Network Engineer defines or approves all network changes. The definition includes:

   - Update instructions
   - Time and prerequisites for update
   - Results and impact of update
   - A "Bail-out" plan, and when to implement it

2. The NMC loads PTFs to the router. If the update cannot be installed remotely by the NMC, the NMC controls the activity at the router.

3. If the current configuration is not compatible with updated router level:

   - Update the configuration files using the configuration program:

     - IP direct route only configuration
     - Functional configuration with all protocols
     - Test configurations such as IP routing protocol

   - Load configurations into the router

   - Update local configuration data sources (verify that instructions and data for configuring IP direct routes are available).

4. Commit PTFs according to instructions. The router reboots with the current configuration.

5. The NMC verifies that the router is functioning according to the update instructions and previous data, documents the update and results, and monitors function for a significant time.

6. New functional configurations are generated and installed by the NMC. After the network is verified as stable at new code level, configurations are changed to use the new capability.

Network Changes

Configuration Build Sequence

Use the following configuration build sequence:

1. Generate router configurations. A typical sequence is:

   a. IP direct routes
   b. IP routing protocols
   c. IP filter and exports
   d. Application 1 protocol
      ⋮
   e. Application *n* protocol

2. Test and/or analyze:

   a. Test bed with load/traffic

      or

      Network engineer with direct experience

   b. Non-critical subnets or segments

      - Implement according to procedure (NMC)
      - Operate for significant time
      - Do three segments without errors or problems

3. Schedule remaining subnets or segments:

   - The NMC implements the changes.
   - When problems occur, drop back to the test bed.

Network Configuration Changes

Update the router code as follows:

1. The Network Engineer defines or approves each configuration.

   - Configurations are named according to established conventions.
   - Each configuration set is in the CDB file by router type.
   - Configuration change instructions are available.
   - A "bail-out" plan is available.

2. The NMC transfers configuration files to the routers.

3. Import the configuration for each router. This requires a defined plan, including router sequence, to:

   - Maintain connectivity
   - Minimize exposure to significant network down time:
     – One router or subset at a time
     – One router every xxx minutes
     – All routers at same time

4. Monitor the network to verify the changes.

5. Document configuration changes and effects.

Network Code Updates

Apply network code updates as follows:

1. Test and/or analyze:

   a. Test bed with load/traffic

      or

      Network engineer with direct experience

   b. Non-critical subnet or segment

      - Implement according to procedure (NMC)
      - Operate for significant time
      - Do three segments without errors or problems

   c. You may use special features or shell scripts:

      - To transmit PTFs to all routers
      - To apply and commit either one at a time (sequence important) or all at once.

2. Schedule remaining subnets or segments:

   - The NMC implements the changes.
   - When problems occur, drop back to the test bed.

3. Stabilize at single code level (single configuration level).

Network Expansion Example

This example involves connecting additional LANs and WANs to the network.

Assumptions:

- This is a tested and established procedure.
- NMC personnel are experienced.
- This is a large network with hundreds of routers.

1. Preparation by the NMC

1. Network Change Instructions are available and approved.

2. The NMC verifies that:

   - Telco links are active between routers Ii and Ni.
   - Telco links are connected to correct ports in Ii.
   - The LAN connections are available and active for Ni.
   - The new routers (Ni) are at the site.

3. The NMC schedules the service representative or network support specialists for each site. Each service representative or support specialist has:

   - A plan and procedures to be used, including information about what to use when.

   - Documentation needed:

     – Phone number for NMC
     – Network diagram and/or data needed
     – Installation and other procedures
     – Port locations
     – Physical location data

- Equipment needed

  - IP direct route Configuration Diskette
  - Diagnostics diskettes
  - Modem and associated cables
  - Terminal and associated cables

Note: Some or all of these items may be available at the site.

2. Key Installation Steps

 1. Each service representative (or support specialist) contacts the NMC from the site and verifies the plan.

 2. Each service representative sets up the router at the site:

    - Verifies that ports are as specified
    - Runs diagnostics if required
    - Positions router in specified location
    - Connects network cables as specified

 3. The NMC installs expansion configurations in the interface routers:

    - Previous functional configurations with new connections added.
    - They may be installed in advance or during previous change.

 4. The service representative contacts the NMC to coordinate the connection of the router (Ni) to the network, and then:

    - Plugs in the power cord with the terminal connected.
    - Configures an IP direct route to the network according to the instructions and data provided.

 5. The NMC completes the direct route configuration.

 6. The NMC verifies connectivity for router (Ni):

    - Tests connectivity to and from each attached port.
    - Tests using network diagram and change instructions.

 7. The NMC multiplexes with all sites to verify connectivity. Problems are debugged and resolved if possible. If problems are not resolved:

    - Expansion proceeds using the connections available.
    - Allowable delays are defined by change instructions.
    - Service call is initiated to resolve the problem.

 8. The NMC installs IP Routing Protocols on each router:

    - Transfers and commits configurations for each router.
    - Tests to verify IP routing for the expanded network:
      - using the Network Change Instructions
      - Checking routing tables, processes running, and so on.

      Note: The service representative may leave the site when IP routing is verified.

 9. The NMC installs application protocols on each router, transfers and commits configurations for each router, and tests to verify that the expanded network is functioning.

10. The NMC documents the expansion and the effect, continues to monitor function for a significant time, and schedules further expansions when stability is verified.

3. Network Roll-Out Plan

This plan summarizes the activities and costs for the network expansion example.

NMC operator (1/2 day):

Adds two to six routers to the network (number dependent on complexity).

Schedules future expansion project:

- Service representative and Telco activity
- Network cable availability

Configuration specialist (1/2 day):

Generates configuration files needed for project (most configurations are generated in advance).

Generates new configurations as needed to:

- Debug or verify a problem
- Correct identified problems

Service representative for each router:

Requires 2 to 5 person-hours per site (each router is at a different site).

NMC user interface specialists (1/2 day x 2 specialists):

- Coordinate new function or change with user groups.
- Prepares users for the change.
- Schedules the change.
- Handles questions and problems.

Roll-out rate and costs:

Based on 16 to 48 routers per week:

8 half-days for adding routers
2 half-days for follow-up problems

Four NMC personnel:

1 Operator
1 Configuration specialist
2 User interface specialists

Total roll-out costs per router:

3 to 10 NMC hours per router

2 to 5 service representative (or network specialist) hours per router

Network Expansion Requirements

This section summaries the network expansion requirements in terms of personnel experience and network controls that must be in place.

1. Experienced Network Installer/Designer

- More than four networks designed, each supported for more than one year
- Hands-on full-time support for a time on each network

2. Experienced Network Installer for the NMC

- More than 4 years hands-on full-time installation and maintenance
- Four different network types including network expansions
- Can quickly generate network diagram from routing tables
- Can recognize symptoms from many different types of problems

3. Network Controls in Place and Working

- Approval of all network changes by the Network Engineer
- Coordination of all network support activity through the NMC
- Network police active and backed by network management
- Documented procedures and controls with flowcharts

4. Local Network Support

- Support personnel with quick access to each node
- Can set up, test, and repair routers and related products
- Can assist network installer and the Network Engineer

Network Configuration Changes

Make network configuration changes as follows:

1. The Network Engineer defines or approves each configuration.

   - Configurations are named according to established conventions.
   - Each configuration set is in the CDB file by router type.
   - Configuration change instructions are available.
   - A "bail-out" plan is available.

2. The NMC transfers configurations to the routers.

3. Import configuration for each router using the special program.

4. Import the configuration for each router using the special program. This requires a defined plan, including router sequence, to:

   - Maintain connectivity
   - Minimize exposure to significant network down time:
     - One router or subset at a time
     - One router every xxx minutes
     - All routers at same time

5. Monitor the network to verify the changes:

   - Observe router status changing as configurations take effect.
   - Check routing tables and other parameters.
   - Check compliance with configuration change instructions.

6. The NMC documents the changes and their impact, and monitors function for a significant time.

Appendix E. Notices

References in this publication to IBM products, programs, or services do not imply that IBM intends to make these available in all countries in which IBM operates. Any reference to an IBM product, program, or service is not intended to state or imply that only IBM's product, program, or service may be used. Subject to IBM's valid intellectual property, or other legally protectable rights, any functionally equivalent product, program, or service that does not infringe any of IBM's intellectual property rights may be used instead of the IBM product, program, or service. The evaluation and verification of operation in conjunction with other products, except those expressly designated by IBM, are the user's responsibility.

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Glossary

This glossary includes terms and definitions from:

- The *IBM Dictionary of Computing* (New York; McGraw-Hill, Inc., 1994).

- 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 *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 Network Working Group Request for Comments: 1208.

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

A. Ampere.

ac. Alternating current.

active. (1) Operational. (2) Pertaining to a node or device that is connected or is available for connection to another node or device.

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

agent. A system that assumes an agent role.

analog. (1) Pertaining to data consisting of continuously variable physical quantities. (A) (2) Contrast with *digital*.

ANSI. American National Standards Institute.

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.

APPN node. Advanced Peer-to-Peer Networking (APPN) node.

asynchronous transfer mode (ATM). A connection-oriented access service to transfer data, voice, and video on broadband networks at very high speeds. These traffic types are mixed together over the available link bandwidth rather than being isolated into dedicated chunks of bandwidth.

The current ATM is for speeds of 155 Mbps and 622 Mbps but it will be capable of speeds in range of gigabits per second.

ATM divides all traffic into fixed-length cells, each containing 48 bytes of user data and five bytes of overhead, and manages the flow of these cells through the network.

ATM. Asynchronous Transfer Mode.

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)

AUI. Attachment unit interface.

autonomous system (AS). A group of networks and routers that use the same interior gateway protocol and for which one administrative authority has responsibility.

B

Bc. Committed burst size.

Be. Excess burst size.

bps. Bits per second.

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.

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.

broadband. A large frequency band allowing different kinds of transmissions, such as coded voice, video, and data, at the same time.

BSC. Binary synchronous communication.

C

CAS. Channel associated signaling.

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 International Telecommunication Union (ITU-TS). "CCITT" continues to be used for recommendations that were approved before the reorganization.

CCS. (1) common channel signaling (2) change control server.

CDB. Configuration database.

CES. Circuit emulation service.

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).

CIR. Committed information rate.

circuit. (1) One or more conductors through which an electric current can flow. See *physical circuit* and *virtual circuit*. (2) A logic device.

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*.

CMIP. Common Management Information Protocol.

CMIS. Common Management Information Services.

CMOT. CMIP over TCP/IP.

CNM. Communication network management.

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.

connection. In data communication, an association established between functional units for conveying information. (I) (A)

CP. Control point.

CRC. Cyclic redundancy check.

CU logical address. The control unit (CU) address defined in the host for the 2216. This value is defined in the host Input/Output Configuration Program (IOCP) by the CUADD statement on the CNTLUNIT macro instruction. The control unit address must be unique for each logical partition defined on the same host.

D

DAS. Dual attaching system (for FDDI).

data circuit. (1) A pair of associated transmit and receive channels that provide a means of two-way data communication. (I) (2) 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 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 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 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.

dc. Direct current.

DCD. DC distribution (module).

DCE. Data circuit-terminating equipment.

DCE. Data circuit-terminating equipment.

DC48. DC power input type -48V.

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.

device. A mechanical, electrical, or electronic contrivance with a specific purpose.

device address. The unit address transmitted on the channel path to select a 2216 device. It is also referred to as subchannel number in S/370 I/O architecture. This value is defined in the host IOCP by the UNITADD statement on the CNTLUNIT macro instruction for the real device.

digital. (1) Pertaining to data that consist of digits. (T) (2) Pertaining to data in the form of digits. (A) (3) Contrast with *analog*.

DLCI. Data link connection identifier.

DLS. Data link switching.

DLUR. Dependent LU requester.

DTE. Data terminal equipment. (A)

DTE. Data terminal equipment.

DTMF. Dual-tone modulation frequency.

DTR. Data terminal ready.

E

E&M. Earth & mark.

EIA. Electronic Industries Association.

EIA unit. A unit of measure, established by the Electronic Industries Association, equal to 44.45 millimeters (1.75 inches).

EIA 232. In data communications, 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.

EMIF. ESCON Multiple Image Facility.

encapsulation. 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. See also *data link switching (DLSw)*.

ESCD. ESCON Director.

ESCON. Enterprise Systems Connection.

ESF. Extended status flags.

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 transmission. Ethernet uses carrier sense multiple access with collision detection (CSMA/CD).

F

FANB.   Fan box.

FAT.   File allocation table.

fax.   Hardcopy received from a facsimile machine. Synonymous with *telecopy*.

FDDI.   Fiber distributed data interface (100 Mbps fiber optic LAN)

FEP.   Front-end processor.

flash memory.   A data storage device that is programmable, erasable, and does not require continuous power. The chief benefit of flash memory over other programmable and erasable data storage devices is that it can be reprogrammed without being removed from the circuit board.

FR.   Frame relay.

FRAD.   Frame relay assembler/disassembler.

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.

frequency.   The rate of signal oscillation, expressed in hertz.

FRFH.   Frame relay frame handler.

front-end processor (FEP).   A processor, such as the IBM 3745 or 3174, that relieves a main frame from the communication control tasks.

FRTE.   Frame relay terminal equipment.

FRU.   Field replaceable unit.

FTP.   File Transfer Protocol.

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.

Gbps.   Gigabits per second (1 000 000 000 bits per second).

GUI.   Graphical user interface.

H

HDLC.   High-level data link control.

high-level data link control (HDLC).   An access service used over data networks. It uses a non-real-time connection.

HDLC-like data link control, for example:

- Synchronous data link control (SDLC) used with SNA, or
- Link access procedure for D-channel (LAP-D) used with ISDN.

high-performance file system (HPFS).   In the OS/2 operating system, an installable file system that uses high-speed buffer storage, known as a cache, to provide fast access to large disk volumes. The file system also supports the coexistence of multiple, active file systems on a single personal computer, with the capability of multiple and different storage devices. File names used with the HPFS can have as many as 254 characters.

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.

hot pluggable.   Refers to an hardware component that can be installed or removed without disturbing the operation of any other resource that is not connected to, or dependant on, this component.

HPDT.   High-Performance Data Transfer.

HPFS.   High-performance file system.

HS.   High-speed.

HSA.   High-speed adapter (module).

HSDS.   High-Speed Digital Services.

HSSI.   High-speed serial interface.

hub (intelligent).   A wiring concentrator, such as the IBM 8260, that provides bridging and routing functions for LANs with different cables and protocols.

I

IDNX. Integrated Digital Network Exchange.

IEEE. Institute of Electrical and Electronics Engineers.

impedance. The combined effect of resistance, inductance, and capacitance on a signal at a given frequency.

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.

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.

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. A worldwide network connecting users through autonomous networks in industry, education, government, and research. The Internet network uses Internet Protocol (IP). The major Internet services include electronic mail, FTP, telnet, World Wide Web, and electronic bulletin boards (Usenet). For network interconnection and routing, and Transmission Control Protocol (TCP) for end-to-end control. (A)

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.

Internetwork Packet Exchange (IPX). 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.

IP. Internet Protocol.

IPX. Internetwork Packet Exchange.

ISDN. Integrated services digital network.

ISM. IBM Solution Manager.

ISMD. IBM Software Manufacturing and Delivery.

ISO. International Organization for Standardization.

ISR. Intermediate session routing.

ITU-T. International Telecommunication Union - Telecommunication (replaces CCITT).

K

Kbps. Kilobits per second (1000 bits per second).

kVA. kilovolt amperes.

L

LAN. Local area network.

LAPD. Link access procedure for D-channel.

LCS. Logical channel station.

LED. Light-emitting diode.

LIC. Line interface coupler.

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 Address. For a 2216 with an ESCON Channel Adapter, a port number determined as follows: If one ESCD is in the communication path, it is the ESCON Director (ESCD) port number that is attached to the host. If two ESCDs are in the path, it is the host-side port number of the ESCD defined with the dynamic connection. When no ESCD is in the communication path, this value must be set to X'01.'.

link connection. 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). Synonymous with *data circuit*.

LMI. Local management interface.

local. Pertaining to a device accessed directly without use of a telecommunication line.

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. See also *Ethernet* and *token ring*. (3) Contrast with *metropolitan area network (MAN)* and *wide area network (WAN)*.

logical partition (LP). A subset of the processor hardware that is defined to support the operation of a system control program (SCP). See also *logically partitioned (LPAR) mode*.

logically partitioned (LPAR) mode. A central processor complex (CPC) power-on reset mode that enables use of the PR/SM feature and allows an operator to allocate CPC hardware resources (including central processors, central storage, expanded storage, and channel paths) among logical partitions. In LPAR mode, the ESCON adapter can share a physical fiber connection with multiple host partitions.

LP. Logical partition.

LP number. Logical partition number. This allows multiple logical host partitions, LPs to share one ESCON fiber. This value is defined in the host Input/Output Configuration Program (IOCP) by the RESOURCE macro instruction. If the host is not using EMIF, use the default of 0 for the LP number.

LPAR. Logically partitioned.

LPAR mode. Logically partitioned mode.

LS. Low-speed.

LSA. Low-speed adapter (module).

M

MAN. Metropolitan area network.

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.

MB. Megabyte (1 000 000 bytes).

Mbps. Megabits per second (1 000 000 bits per second).

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.

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.

MPC. Multi-Path Channel.

MPC+. High-Performance Data Transfer (HPDT) Multi-Path Channel.

ms. Millisecond (1/1000 second).

N

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 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 management. The process of planning, organizing, and controlling a communication-oriented data processing or information system.

NIC. Network Information Center.

NMS. Network management station.

NNI. Network-to-network interface.

non-return-to-zero change-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.)

NRZ-1. Non-return-to-zero change-on-ones recording.

NSAP. Network service address point.

NSC. Network Support Center.

NVDM. NetView Distribution Manager/6000.

O

OC. Optical carrier.

OSI. Open systems interconnection.

P

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*.

PBX. Private branch exchange.

PCM. Pulse code modulation.

PDH. Plesiochronous digital hierarchy.

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).

physical circuit. A circuit established without multiplexing. See also *data circuit*. Contrast with *virtual circuit*.

PM. Presentation Manager.

PMF. Parameter Management Frame.

PNP. Private numbering plan.

Point-to-Point Protocol (PPP). A protocol that provides a method for encapsulating and transmitting packets over serial point-to-point links.

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. Synonymous with *socket*. (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.

PPP. Point-to-Point Protocol.

PR/SM. Processor Resource/Systems Manager.

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.

Processor Resource/Systems Manager (PR/SM). The feature on a 3090 Processor Complex that offers flexible partitioning of a 3090 processing system into a number of logical partitions. Each partition within a PR/SM environment supports its own MVS or VSE image and VTAM, resulting in a multi-MVS or VSE environment.

PRS. Primary reference source.

PSN. Public switched network.

PSTN. Public switched telephone network.

PTM. Packet transfer mode.

PVC. Permanent virtual circuit.

Q

QoS. Quality of service.

R

rack. A metallic structure, with a standard 19-inch width, that houses Nways Switch hardware elements: logic subrack with modules, fan boxes, and power subrack with power units.

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.

RETAIN. Remote Technical Assistance Information Network.

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.

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.

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. Contrast with *bridge* and *gateway*. (3) In OSI terminology, a function that determines a path by which an entity can be reached.

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.

RSC. Remote Support Center.

RSF. Remote Support Facility.

RT. Real time.

S

s. Second.

SDH. Synchronous digital hierarchy.

SDLC. Synchronous Data Link Control.

SDT. Structured data transfer.

Serial Line Internet Protocol (SLIP). A TCP/IP protocol used on a point-to-point connection between two IP hosts over a serial line (for example, an RS/EIA-232 connection into a modem over a telephone line).

In an NBBS network, the SLIP is used over a connection between an Nways Switch administration station (NAS) and an IBM Network Support Center (NSC).

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).

SLA. Serial link architecture.

SLIP. Serial Line Internet Protocol.

SNA. Systems Network Architecture.

SNMP. Simple Network Management Protocol.

socket. 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.

SONET. Synchronous optical network.

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.

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.

SRC. System reference code.

STM-1. Synchronous transport module-1.

SW. Switch (module).

SWRD. Switch redrive (module).

synchronous. (1) Pertaining to two or more proc-
esses that depend upon the occurrence of specific
events such as common timing signals. (T) (2) Occur-
ring with a regular or predictable time relationship.

Synchronous Data Link Control (SDLC). A discipline
conforming to subsets of the Advanced Data Communi-
cation 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) Contrast with *binary syn-
chronous 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.

system. In data processing, a collection of people,
machines, and methods organized to accomplish a set
of specific functions. (I) (A)

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 informa-
tion, that is, the end users, to be independent of and
unaffected by the specific SNA network services and
facilities used for information exchange.

T

TCP. Transmission Control Protocol.

TCP/IP. Transmission Control Protocol, Internet Pro-
tocol.

TDM. Time division multiplexing.

Telnet. In TCP/IP, an application protocol that allows a
user at one site to access a remote system as if the
user's display station were locally attached. Telnet
uses the Transmission Control Protocol as the under-
lying protocol.

TFTP. Trivial File Transfer Protocol.

time division multiplexing (TDM). See
channelization.

TN3270. An informally defined protocol for transmitting
3270 data streams over Telnet.

TN3270. An informally defined protocol for transmitting
3270 data streams over Telnet.

token. (1) In a local area network, the symbol of
authority passed successively from one data station to
another to indicate the station temporarily in control of
the transmission medium. Each data station has an
opportunity to acquire and use the token to control the
medium. A token is a particular message or bit pattern
that signifies permission to transmit. (T) (2) In LANs, a
sequence of bits passed from one device to another
along the transmission medium. When the token has
data appended to it, it becomes a frame.

token ring. (1) According to IEEE 802.5, network
technology that controls media access by passing a
token (special packet or frame) between media-attached
stations. (2) A FDDI or IEEE 802.5 network with a ring
topology that passes tokens from one attaching ring
station (node) to another. (3) See also *local area
network (LAN)*.

Transmission Control Protocol (TCP). A communi-
cations protocol used in 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 commu-
nications networks and in interconnected systems of
such networks. It assumes that the Internet protocol is
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 Control Protocol/Internet Protocol
(TCP/IP)**. A set of communication protocols that
support peer-to-peer connectivity functions for both local
and wide area networks.

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.

Trivial File Transfer Protocol (TFTP). In the Internet
suite of protocols, a protocol for file transfer that
requires minimal overhead and minimal capability.
TFTP uses the connectionless datagram delivery ser-
vices of the User Datagram Protocol (UDP), which

allows hosts that have no disk storage to implement TFTP in read-only memory (ROM) and use it to boot themselves.

U

UDP. User Datagram Protocol.

UNI. User network interface (protocol).

UTP. Unshielded twisted pair.

V

V ac. Volts alternating current.

V.24. In data communications, 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 communications, 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.35. In data communications, 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 communications, 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.

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.

VPD. Vital product data.

W

WAN. Wide area network.

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 communications network designed to serve an area of hundreds or thousands of miles; for example, public and private packet-switching networks, and national telephone networks. Contrast with *local area network (LAN)* and *metropolitan area network (MAN)*.

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. An International Telegraph and Telephone Consultative Committee (CCITT) recommendation for the interface between data terminal equipment and packet-switched data networks. See also *packet switching*.

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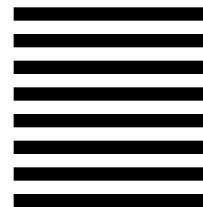**Tell Us What You Think!**
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