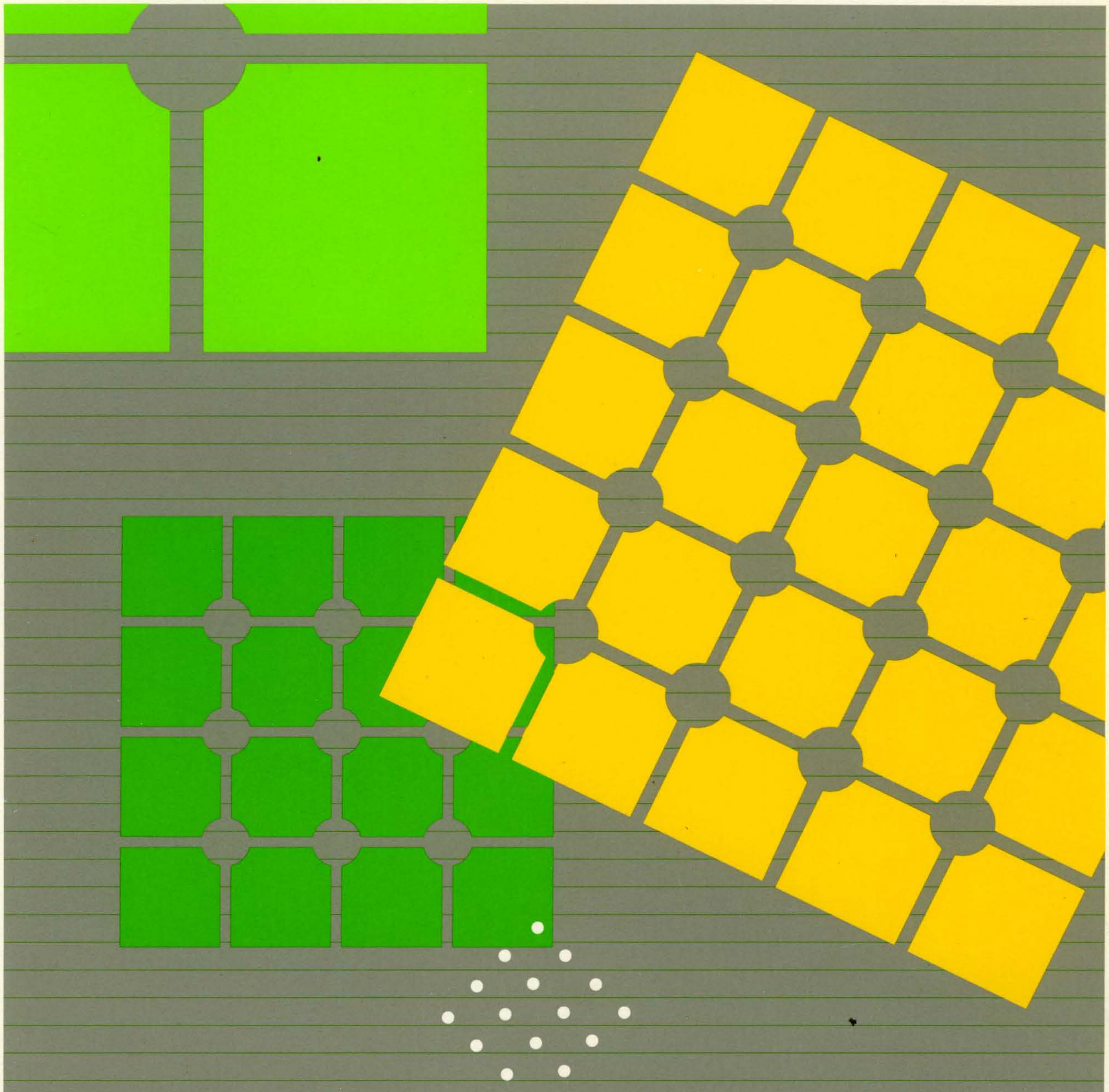
IBM

Local Area Network

GA27-3748-03

Administrator's Guide



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GA27-3748-03

Fourth Edition (March 1991)

This is a major revision of and obsoletes *IBM Local Area Network Administrator's Guide*, GA27-3748-02. Refer to the Summary of Changes page for details about the changes. Changes are made periodically to the information herein; these changes will be incorporated in new editions of this publication.

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System Security Advice

The products described in this book are intended for use within a single establishment and within a single, homogeneous user population. For sensitive applications requiring isolation from each other, management may wish to provide isolated cabling or to encrypt the sensitive data before putting it on the network.

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Preface

This manual provides information helpful to the administrator of a local area network (LAN) in performing the activities involved in planning, installation, and management of the network.

The network administrator needs a thorough understanding of:

- LAN concepts and operation
- The requirements and functioning of the establishment
- Concepts, use, and operation of the attaching products (hardware and programs) used in the network.

The administrator has the primary responsibility of managing the daily operation and workload of the network. This person may also have responsibility for or participate in the following administrative activities:

- Software selection, installation, and documentation for the network
- Assistance to the network planner in network hardware layout, installation, and documentation
- Selection and implementation of devices and software used to connect multiple LANs and to connect LANs to other types of networks
- Education and training for network users and operators
- Network access and use procedures
- Network security
- Network problem analysis and resolution.

System planners, installation planners, system programmers, consultants, and customer assistance groups may also refer to this manual.

Using This Manual

To use this manual most effectively, you should:

- First, read Chapter 1 to become familiar with the terms and concepts that apply to IBM LANs.

  These terms and concepts are repeated in the rest of the manual as they apply to specific networks.

- Then, locate and read the chapters or sections in each part of the manual that apply to your networks and your assigned responsibilities as a network administrator.

Manual Contents

Part 1 describes **terms and concepts** associated with IBM LANs, including topologies, hardware and software components, protocols, addressing, network management, and problem resolution.

Chapter 1 contains an **overview** of IBM LANs.

Chapter 2 provides an **overview** of the IBM Token-Ring Network.

Chapter 3 provides an **overview** of the IBM PC Network Broadband.

Chapter 4 provides an **overview** of the IBM PC Network Baseband.

Chapter 5 provides an **overview** of the Manufacturing Automation Protocol (MAP) network.

Chapter 6 provides an **overview** of the Ethernet LAN.

Part 2 describes the **role and activities** of a local area network administrator and discusses the administration activities involved in network planning, installation, daily management and operation, and problem resolution.

Chapter 7 describes briefly the **role of the network administrator** and the activities and responsibilities that might be involved in the administration of a LAN.

Chapter 8 describes the administrative activities related to **planning** the organization, installation, and modification of a LAN.

Chapter 9 describes the administrative activities involved in network hardware and software **installation**.

Chapter 10 describes the activities necessary to the daily management and **administration** of network operation and workload.

Chapter 11 describes activities related to network **problem determination** and resolution.

Part 3 describes IBM **programs, interfaces, and operating systems** that:

- Support application programs in their use of the network
- Provide interconnection of networks and systems
- Provide diagnostics, error indications, and performance statistics.

The description of each program includes its major purpose in the network, its functions and options, and its network requirements, restrictions, and other considerations.

Chapter 12 describes **programs** that provide standard **interfaces** and **support** for communication across the network and communication between application programs and LAN adapters.

Chapter 13 describes **programs** that provide information about malfunctioning hardware; network **problems** and error conditions; and network traffic flow, **performance**, and utilization.

Chapter 14 describes **programs** that provide **network management** functions, either on a LAN or from a remote host or another network.

Chapter 15 describes the **products** that are used to **bridge** single LANs together into larger networks.

Chapter 16 describes the **programs** that provide **gateway** functions, device **emulation**, **server** functions, and connections to **remote** stations, controllers, and hosts.

Chapter 17 describes **operating systems** used by LAN-attaching devices and remote processors.

Appendix A contains a list of related publications for IBM LANs, a brief description of each publication, and instructions for obtaining them.

Appendix B contains bridge performance analysis and calculation worksheets used to evaluate traffic flow through a bridge.

Appendix C contains a checklist and summary of administrative tasks and activities, with references to publications and chapters of this manual that discuss or explain the activities.

A list of abbreviations, a glossary, and an index are provided at the back of this manual.

Related Publications

In addition to this *IBM Local Area Network Administrator's Guide*, the network administrator will consult many of the publications related to IBM LAN planning, installation, operation, software, and problem analysis and resolution. The following lists include the IBM publications most often needed.

For the IBM Token-Ring Network:

- *IBM Token-Ring Network Introduction and Planning Guide*
- *IBM Token-Ring Network Installation Guide*
- *Guide to Operations* and *Installation Instructions* for adapters and attachment features
- *IBM Local Area Network Support Program User's Guide*
- *IBM Token-Ring Network Problem Determination Guide*.

For the IBM PC Network*:

- *IBM PC Network Broadband Planning Guide*
- *IBM PC Network Baseband Planning Guide*
- *Installation Instructions* for adapters and attachment features
- *IBM Local Area Network Support Program User's Guide*.

For a MAP Network:

- *IBM 3172 Interconnect Controller Operator's Guide*.

For an Ethernet Network:

- *IBM 3172 Interconnect Controller Operator's Guide*
- *IBM 8209 LAN Bridge Attachment Module Guide for Ethernet and IEEE 802.3 LANs*.

The network administrator may also refer to manuals discussing similar topics for the IBM Cabling System, IBM Personal Computers, IBM Industrial Computers, IBM Personal System/2* (PS/2*) computers, attaching products, and application programs used in the network.

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Summary of Changes

This revision includes:

- Addition of Manufacturing Automation Protocol (MAP) and Ethernet/IEEE 802.3 LAN overviews and support program descriptions
- Discussion of new and enhanced LAN hardware components
  - IBM 8230 Token-Ring Network Controlled Access Units
  - IBM 3172 Interconnect Controller
  - IBM 8209 LAN Bridge
- Additional descriptions of controllers and host processors, their support programs, and their connection to LANs
- Addition of operating system overviews, including Operating System/2* (OS/2*) Extended Edition 1.2
- Descriptions of new and revised network support programs:

  IBM Interconnect Controller Program

  - Enables communication between a host and an IBM 4 or 16 Mbps Token-Ring Network, Ethernet Network, or MAP 3.0 Network

  IBM LAN Network Manager

  - Uses a OS/2 Presentation Manager-based user interface.
  - Provides network management for the IBM PC Network Broadband, IBM PC Network Baseband, and the IBM Token-Ring Network across bridges
  - Responds to NetView* operator commands for LAN segment and adapter status and for error recovery and control functions
  - Provides the auto-link feature for bridging
  - Supports the IBM 8209 LAN Bridge
  - Provides asset management and access control functions to prevent unauthorized adapters from being present on the network

  IBM Local Area Network Asynchronous Connection Server (LANACS)

  - Operates on an IBM Token-Ring Network, IBM PC Network, or Ethernet Network
  - Provides Disk Operating System (DOS) or OS/2 LAN-attached workstations access to Off-Net Asynchronous ASCII functions

  IBM 8209 LAN Bridge Utility Program (Versions 1.0, 2.0, and 3.0)

  - Provides advanced configuration functions to change the values of IBM 8209 configuration parameters (all versions)
  - Provides the Bridge Profile functions to display current configuration parameter values (all versions)
  - Can load a filter program into the IBM 8209 (Version 3.0 token-ring to token-ring only)

IBM Local Area Network Support Program (Version 1.2)

- Provides adapter support and associated program interfaces for the IBM PC Network, the IBM Token-Ring Network, and the Ethernet/IEEE 802.3 LANs
- Allows network application programs to access the adapters and allow the user to run programs written for one type of network on another type of network

IBM PC Network Bridge Program

- Provides support for the IBM PC Network Baseband

IBM Token-Ring Network 16/4 Trace and Performance Program

- Provides functions that monitor and analyze trace data and ring utilization on a single 4 or 16 Mbps IBM Token-Ring Network Segment
- Collects ring station traffic statistics

IBM Token-Ring Network Bridge Program Version 2.2

- Supports increased frame sizes (to 8144)
- Provides a remote-dial feature for the remote bridge function

IBM LAN to LAN Wide Area Network Program

- Allows NETBIOS LANS to communicate using an existing telecommunications network.
- Allows stations that use the NETBIOS interface to communicate on LANs connected through an existing wide area network.

Part 1 — Local Area Networks

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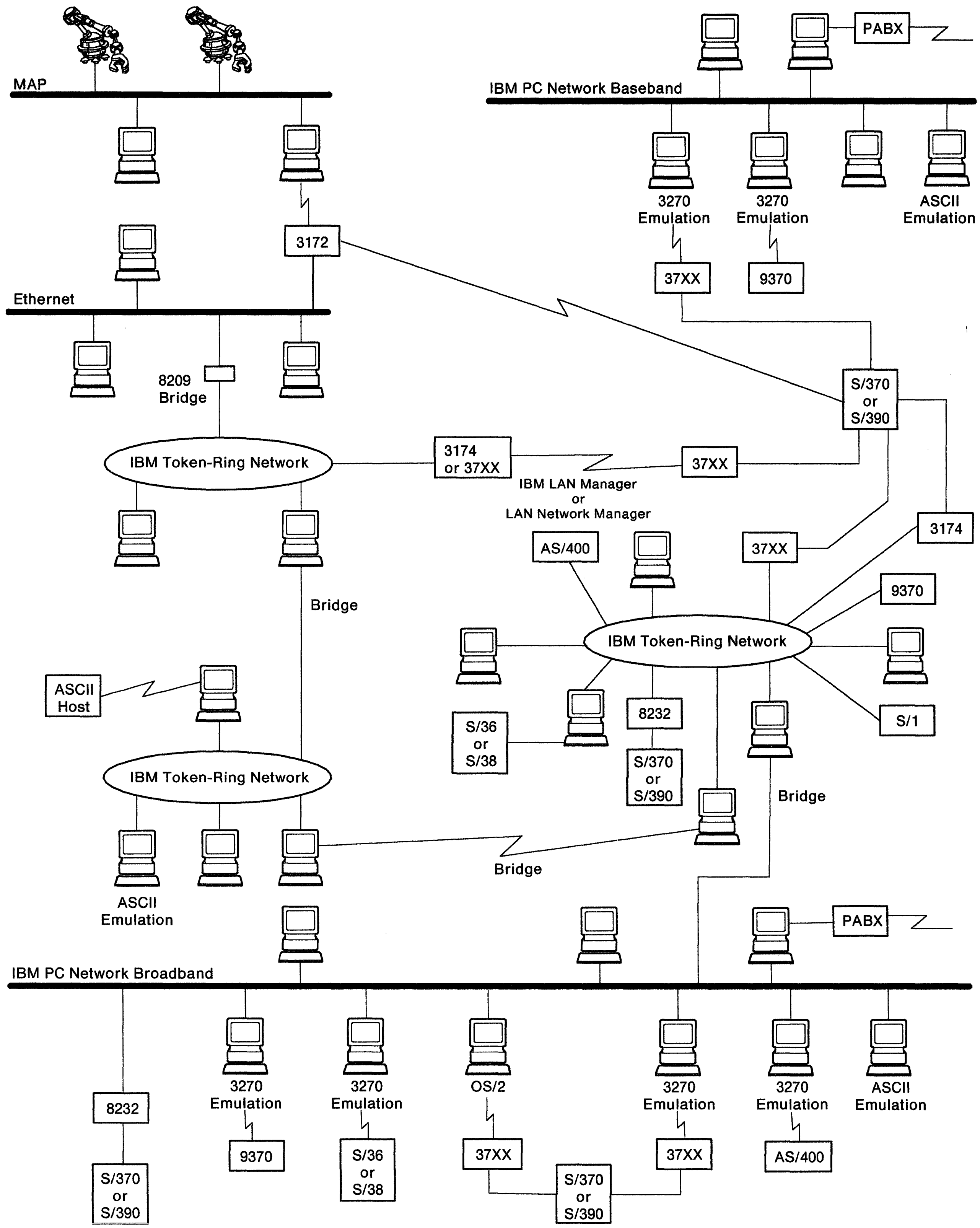

Figure 1-1. A Composite LAN

Overview of Local Area Networks

Modern computer technology has made it possible for us to use small but powerful individual workstations, such as word processors and personal computers, to increase the speed and efficiency of data processing tasks.

One of the most recent technological advances is the network. Network hardware and software components connect individual workstations, controllers, and host computers (collectively called stations or devices) to allow the exchange of information and sharing of resources.

A local area network (LAN) provides direct data connection among devices within the user's premises (or establishment), usually without crossing any public right of way.

Figure 1-1 shows a composite LAN. This composite network includes an IBM* Token-Ring Network portion, an IBM PC Network Broadband portion, an IBM PC Network Baseband portion, an Ethernet network, and a Manufacturing Automation Protocol (MAP) portion. The figure also shows many of the devices that may be connected to these types of LANs.

LANs have the following characteristics:

- Data transmission occurs serially from one station to another over small distances, usually less than 10 km (6.2 mi.).
- Data transmission rates are between 1 and 100 Mbps.
- The establishment usually owns the internal cabling between stations.
- Users may be able to access, but do not function as part of, wide area and public switched (telephone) networks.
- All stations are capable of
  - Supporting complicated protocols
  - Sensing network and media status
  - Participating in network control and management functions.

In comparison, wide area networks (WANs) have these characteristics:

- Can extend over much larger distances (thousands of miles)
- Usually have lower data transmission rates
- Do not require stations to be capable of supporting complicated protocols or of handling network control functions; one or a few hosts provide central points of network control.

Public switched networks can provide voice and data connections to many users. The connected parties have exclusive use of the connection until it is released. Public switched networks generally have these characteristics:

- Cover great distances
- Use a variety of transmission media (wires, optical fiber, microwaves, and satellites, for example)
- Provide public circuit access equipment and services, equipment for private dedicated use, and a combination of both.

LANs can increase their information exchange and resource sharing capabilities through communication with wide area and public switched networks.

The following conditions must be met for communication to occur on a LAN:

- The stations must be connected by a physical medium that can carry information from one station to another.
- Each station must have a method of accessing the medium.
- All stations on the network must have a common and standard way of sending, receiving, and interpreting information carried by the network.

Topologies

Topology refers to the physical, geometrical layout of cable to connect devices in a network.

The technology used for any of the network topologies imposes a limit on the number of devices that can be physically connected to one LAN. However, the technology does provide bridging products for connecting LANs together to form larger networks. The smaller networks then become *segments* of the larger network. The technology allows connection of the same or different types of LAN segments in topologies providing single or multiple (also called parallel) paths between any two LAN segments.

LAN Segment Topology

Most LAN segments use some variation or combination of three basic topologies: star, bus, and ring.

- Star

  In a star-wired network, every device is directly connected to a central switching point. For example, telephones connected to a private branch exchange form a star network. A device sends a connection request to the switch, and the switch sets up the two-way connection with the requested device. Failure of the switch disables the network.

- Bus

  A bus is a two-way transmission path with defined end points. For example, the IBM PC Network Baseband, Ethernet, and MAP LAN segments use bus topology. All devices connect directly to the bus. A transmission from one device travels in both directions to the ends of the bus and thus to every device on the bus. Each station looks at identifying information in each transmission, and accepts transmissions that contain its assigned identifier (or address). Other transmissions are ignored. A break in the bus disables the network.

- Ring

  A ring is a logically circular, one-way transmission path without defined ends. A transmission generated at a device passes to the next device, where the signal is regenerated before being passed on to the next device. Each device looks for its identifier in the transmission, and accepts transmissions containing its identifier. The sender can get confirmation that the transmission was received by checking the transmission as it comes back around the ring. Breaks are easily identified through failure of the sender to receive confirmations, timing checks, and interrogation of the status of each device.

- Tree

  A tree is an extension of bus topology. The main bus connects smaller branch buses to which devices are connected. For example, cable television (which uses community antenna television, or CATV), the IBM PC Network Broadband, and MAP use tree topology.

- Star-wired ring

  This topology combines the physical wiring of a star and the logical wiring of a ring, providing flexibility in connecting devices and easier failure detection. For example, the IBM Token-Ring Network uses star-wired ring topology. Each device is connected to a switching point (or access unit), and switching points can be connected to form a larger ring. The switching points connect the devices into a logical ring, and can electrically attach devices to and remove devices from the ring as required (the device remains physically connected).

Network Topology

Topologies also describe the way LAN segments are connected together to form larger LANs.

LANs may include products that bridge LAN segments of the same or different types. For an organization (or enterprise) that consists of two or more establishments separated by great distances or by public rights of way, LANs may include products that use public switched networks to provide remote connections between LAN segments located in separate establishments.

LAN segments may be interconnected in many different ways to form networks.

- Mesh

  A mesh network provides *multiple* paths through intermediate LAN segments between a source LAN segment and a destination LAN segment.

- Hierarchical

  A hierarchical network provides only *one* path through intermediate LAN segments between a source LAN segment and a destination LAN segment.

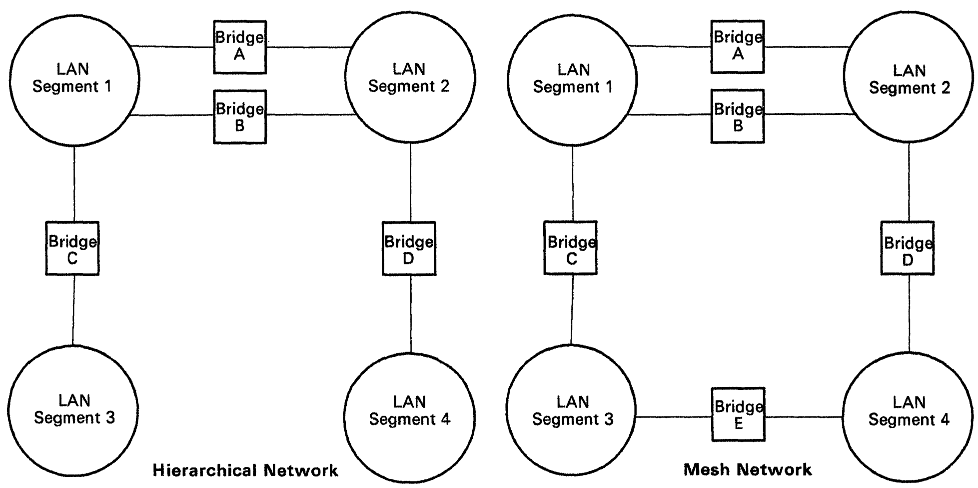

Figure 1-2. Hierarchical and Mesh Network Configurations

A hierarchical or mesh topology can include a central or backbone LAN segment to which multiple LAN segments are connected. A backbone LAN segment can provide:

- The shortest average path between two devices in the network
- The most direct path to shared devices and resources.

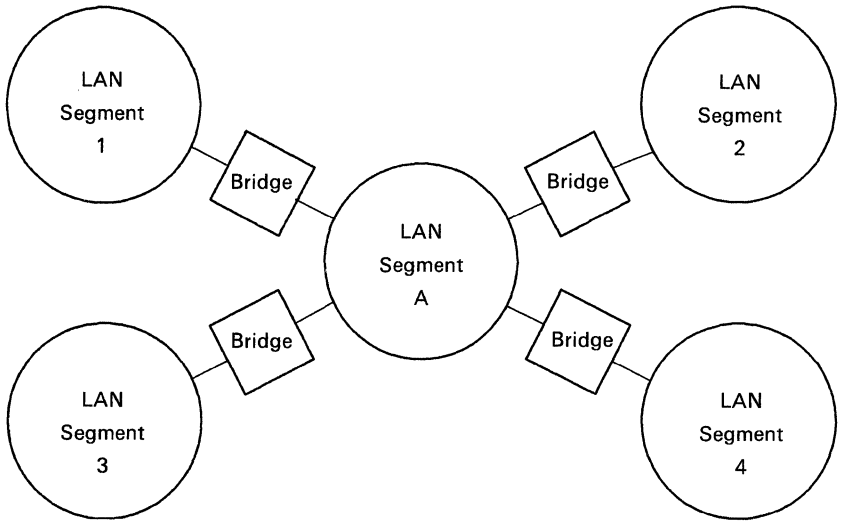

Figure 1-3. A Backbone Connection

Hardware Components

Three categories of physical (or hardware) components are used to construct LANs and connect stations to them.

Transmission media
Cables containing copper wire or optical fiber.

Network adapters and attachment features
Collections of circuitry and microcode that are installed in the devices that use the network in order to connect a device physically to the network and to send and receive information over the network.

Access, translation, regeneration, and conversion units
These units provide one or more of the following network functions:

- Connect devices to the network
- Strengthen and retransmit electrical signals to allow greater distances between devices or access units
- Translate information signals from one electrical frequency to another
- Convert information signals from one transmission medium to another.

Transmission Media

The physical medium used to carry information between stations in a LAN is cable. LANs can use copper wire cable and optical fiber cable.

The type of cable used in a network depends on a number of factors, including:

- Data transmission rates

  LAN data transmission rates vary between 1 and 100 Mbps, depending on the type of network and the components used to construct it.

- Distances

  "Local" usually refers to distances of less than 10 km (6.2 mi.) either between network units and devices or in the total length of cable used in the network. "Extended runs" are usually greater than a few hundred feet or meters.

- Electrical noise, interference, and emissions

  The signals carried by copper wire are susceptible to outside electrical interference and can emit such interference if cable shielding is insufficient. Optical signals are immune to and do not emit electrical interference.

- Signal loss (attenuation)

  The characteristics of copper wire and its susceptibility to electrical interference cause degeneration of the transmitted signal. Regeneration of the signal to preserve data integrity can be done by the stations or by units designed for that purpose. Optical fiber cable can carry a signal over much greater distances than copper wire before experiencing signal attenuation.

- Transmission technique

  IBM LANs use two transmission techniques (see "Transmission Techniques" on page 1-13):

  – Broadband networks use analog signal technology with frequency modulation of the signal.

  – Baseband networks use digital signal technology to transmit data in patterns of binary digits (or bits).

Media Types

The following is a list of the types of cable and their characteristics used in LANs:

- Telephone twisted-pair

  – One or more twisted pairs of copper wire in the unshielded voice-grade cable commonly used for connecting a telephone to its wall jack

  – Can transmit data when the signal strength is filtered, distances are short, and data transmission rate is relatively low

  – Susceptible to electrical interference and high signal attenuation; can radiate radio-frequency (RF) emissions

  – Used for data transmission rates not greater than 4 Mbps

  – Supports only baseband transmission

- Coaxial cable

  – High data rates for relatively long distances
  – Low attenuation
  – Low RF emissions and interference susceptibility
  – Supports broadband and baseband transmission
  – Comes in several types, including those commonly used for CATV

- Shielded twisted-pair

  – One or more twisted pairs of copper wire in a shielded data-grade cable
  – Less interference susceptibility and RF emissions than unshielded cable
  – Used for data transmission rates under 20 Mbps
  – Supports baseband and broadband transmission

- Optical fiber

  – High data rates (exceeding 100 Mbps) over longer distances than with copper wire cable, without signal regeneration

  – Immune to electrical interference and does not radiate emissions

  – Very little signal attenuation

  – Used for baseband transmission; can be used for broadband transmission if time-division multiplexing (TDM) is used to distinguish frequency channels.

Network Adapters and Attachment Features

Each device (or *station*) that uses a LAN must have installed in it at least one network adapter or attachment feature. For simplicity, the remainder of this book refers to "network adapters" and "network attachment features or modules" as "adapters." An adapter consists of:

- A circuit card containing electrical components and a cable connector
- Microcode (usually on the circuit card) that controls sending and receiving information on the network.

One or more adapters can be installed in a device by the user or at the time the device is manufactured. One end of a cable connects to the adapter. The other end of the cable connects to a network connection point or to the adapter of another network station.

Software runs in the device in which an adapter is installed, in order to:

- Operate the device
- Generate and receive the information carried on the network
- Direct the adapter to become active on the network (attach or insert) or to cease being active on the network (remove).

Hardware switches, hardware jumpers, or software allow the user to define adapter functions, parameters, and options, such as:

- The name or address by which other adapters and stations on the network can recognize this adapter and station
- The methods or functions by which the network adapter and device circuitry, software, and microcode will exchange control and information
- The device and adapter resources that are needed for communication and information (especially those that may be shared, like computer memory and buffer space).

Attaching Devices

In order to connect to and use a LAN, a device must be able to:

- Support the complex protocols used for network communication, through adapter and device microcode, support programs, and application programs
- Participate in network management and control processes, through adapter microcode, support programs, and network application programs.

Most of the devices that connect directly to LANs are types of personal computers or *workstations*, including:

- IBM Personal Computers
- IBM Industrial Computers
- IBM Personal System/2* (PS/2*) computers
- IBM RT Personal Computer* (RT PC*).
- IBM RISC System/6000.

Workstations can function as host computers or controllers, but they are not designed exclusively for that purpose.

Controllers and small host computers can also connect directly to a LAN if they can accommodate installation of a network adapter or attachment feature and appropriate support software.

Controllers that can connect directly to IBM LANs include:

- IBM 3720 Communications Controller
- IBM 3725 Communications Controller
- IBM 3745 Communications Controller
- IBM 3174 Establishment Controller
- IBM 3172 Interconnect Controller.

Host computers that can connect directly to IBM LANs include:

- IBM 9370 Information System
- IBM AS/400*
- IBM Series/1*.

Peripheral devices (including printers, tape units, cassettes, disk drives, scanners, and plotters) usually cannot connect directly to a LAN. They cannot accommodate installation of a network adapter and cannot support the network protocols and management and control functions. They require the support of a network workstation, host, or controller to which they are connected.

Some terminals (such as System/36 or 38 terminals) and displays (including 327X displays) designed to connect to a host computer or controller, cannot accommodate a network adapter or support network protocols. When the host or controller is connected to a LAN, such terminals and displays may be used to initiate and conduct communication with LAN workstations that emulate similar functions. A workstation with the required combination of adapters and software can emulate the function of such a terminal, host, or controller. Device emulation allows:

- Use on a LAN of applications originally written for these devices
- Communication from a workstation on a LAN with application programs that use such a device on another type of network.

Access, Translator, Regeneration, and Conversion Units

Some LANs are constructed simply by connecting each network adapter to its neighbors with cables. Either the last station connects to the first one to complete the physical path, or the two end stations contain a means to "wrap" or "terminate" the connection. No other hardware components are required to enable communication on the network.

Most LANs, however, use additional pieces of hardware to provide physical connection points to the network adapters and to provide signal conversion, translation, and regeneration. These pieces of hardware include:

- Access units

  Access units provide connectors for the opposite ends of the cables that are connected to network adapters. They can serve as wiring concentrators, providing a central connection and switching point (as is done in star-wired networks). Some types of access units can also be connected to one another to allow more devices to use a network. Some access units may also provide intelligence and can aid in problem determination, access management, and security.

Transceivers, extenders, splitters, and couplers are other types of hardware used to provide direct access to a network and to increase the number of adapters that can connect to a network.

Modems, private branch exchanges, and other types of telecommunication equipment provide access to public switched networks from LANs. Devices on the LANs can then communicate with devices on wide area networks (WANs) and on remote LANs.

- Translator units

  Networks that use more than one signal frequency require a translator unit to allow communication between frequencies. Stations on networks using broadband transmission often use one frequency for sending information to the network and another frequency for receiving information from the network. This allows simultaneous sending and receiving at a station, but requires a translator unit at some point in the network to convert the sending signal to the receiving frequency.

  Some translator units handle only one pair of frequencies. Other translator units can handle two or more frequency pairs, allowing devices using different frequency pairs to use the same transmission medium. Most translator units convert signals only between the sending and receiving frequency of a pair, not between different pairs. Multiple frequency pairs can share the same network, but communication cannot occur between them unless a bridging product is used in the network to connect different frequency pairs.

- Regeneration units

  Some LANs require the signal to be regenerated or repeated periodically to preserve data integrity. The stations on these networks usually have the function to regenerate the signal before they send it to the next station.

  If the distance between two stations or access units is greater than the maximum allowed to preserve the signal, a piece of hardware (such as a repeater) is used between the two stations or access units to regenerate the signal. The maximum distance allowed between stations is thereby increased.

- Conversion units

  Converters make it possible to use copper wire and optical fiber cables in the same network. Converters change an electrical signal from a copper wire into a light signal on an optical fiber and vice versa.

  Optical fiber is generally used over long distances between access units to allow for higher data rates and less signal loss. Copper wire cable is usually used between adapters, and between an adapter and an access unit.

Data Transmission

A LAN transmits information over the network physical media at a rate between 1 and 100 Mbps. Information is always transmitted at the same rate on a given LAN segment. The network adapters and cable types used in a LAN segment determine the rate at which the LAN segment can carry information.

The IBM PC Networks (Broadband and Baseband) transmit data at 2 Mbps. The IBM Token-Ring Network transmits data at 4 or 16 Mbps, depending on the type of adapter used. Ethernet networks transmit data at 10 Mbps. MAP LANs transmit data at either 5 or 10 Mbps depending on the hardware used.

Transmission Techniques

IBM LANs use three techniques to transmit information as signals over the physical medium (or cable): broadband, baseband, and carrierband.

- Broadband transmission

  Broadband transmission uses radio frequency modems to generate analog signals of multiple frequencies on the same physical medium. The cable bandwidth is divided into frequency ranges or channels (through Frequency Division Multiplexing or FDM), allowing multiple transmissions to occur in the same cable and in both directions at once. Users can share each channel by using it during allocated time slices (Time Division Multiplexing or TDM). Voice, data, and video signals can share a single cabling system. Only devices using the same range or channel can communicate with each other unless the network includes equipment to translate signals from one frequency range to another.

- Baseband transmission

  Baseband transmission generates a single signal on the transmission medium without the use of modems. Users share the channel through TDM. Each user accesses the entire bandwidth during his time slice.

- Carrierband Transmission

  A carrierband transmission is a frequency band in which the modulated signal is superimposed on a carrier signal (as differentiated from baseband), but only one channel is present on the medium (as differentiated from broadband).

Media Access Methods

IBM LANs use variations of two basic methods to access the network physical medium: contention and token-passing.

Contention

The IBM PC Network Broadband and the IBM PC Network Baseband (and the Ethernet/IEEE 802.3 LANs) use the carrier sense multiple access with collision detection (CSMA/CD) method of contention.

Each station continually senses the carrier or signal on the bus to determine whether another station is transmitting. If no other station is transmitting, a station can begin its transmission and risk that another station will also begin to transmit at the same time.

If two stations do begin simultaneous transmission, their transmissions will collide on the medium. Each station detects that a collision has occurred, stops transmitting data, sends out a temporary jamming signal, waits a random length of time, and attempts the transmission again.

Token-Passing Ring

A *token* is a unique sequence of bits in 3 bytes transmitted on the LAN segment. The token consists of a start delimiter, a control field, and an end delimiter.

Token-passing rings transmit data in only one direction on the network. A station that is ready to transmit information must wait until it receives the token. The station inserts data and control information into the token to convert the token bit pattern to a frame, and transmits the frame over the network. The control information includes routing addresses and frame checking information.

The receiving station copies the frame from the network, marks it as received, and returns a copy to the sending station. The sending station removes the frame from the network and sends out a new token onto the network. The IBM Token-Ring Network uses a token-passing ring.

Most LANs that use token-passing allow only one token or one frame to circulate on the network at a time. The IBM Token-Ring Network 16/4 adapters support a data transmission rate of 16 Mbps and provide the Early Token Release function, which allows one token and one or more frames to circulate at the same time.

Network Architecture

The hardware components and physical media in a LAN provide the connection or vehicle over which communication takes place.

The use of that vehicle to accomplish an orderly exchange of information on a network further depends on the use of a common network architecture: a standard structure and set of operating principles for network access, function, and management.

Such a structure and set of operating principles can be represented in a *reference model*, which:

- Divides the tasks to be accomplished in communication on a network into groups, or layers
- Describes the tasks that each layer is to accomplish
- Describes the exchange of information that needs to occur between the layers.

Reference models for networks are:

- The IBM Systems Network Architecture (SNA) Reference Model

  IBM developed SNA for WANs connected to System/370 hosts. SNA is a proprietary seven-layer architecture.

- The International Standards Organization (ISO) Open Systems Interconnection (OSI) Reference Model

  The Open Systems Interconnection (OSI) Reference Model:

  - Outlines the tasks performed at seven levels or layers of network communication and management
  - Defines the relationship of each user to the system.

  The OSI Reference Model is similar to the SNA model and includes WANs and LANs.

  The MAP task force under the leadership of General Motors defined a uniform set of protocols. MAP uses the OSI reference model as a basis for their architecture.

- The Institute of Electrical and Electronics Engineers, Inc. (IEEE) 802 Reference Model

  The IEEE established Project 802, a group of committees working on LAN standards. The IEEE 802 Reference Model specifically defines two layers for LANs that correspond to the two lowest layers of the SNA and OSI Reference Models. Although the IEEE 802 Reference Model considers the five higher layers for LANs, the precise definition of these layers depends on the interfaces and protocols being used by an application program on the network.

  XEROX, Intel, and Digital Equipment Corporations jointly defined the Ethernet specification. The current revisions of the IEEE 802.3 standard and the Ethernet specifications are compatible.

The table on page 1-16 summarizes the reference models. The sections following the table describe layers, protocols, and interfaces in more detail.

Table 1-1. Conceptual Summary of Network Architecture Reference Models

SNA	OSI	MAP
Transaction Services • Application and end-user services (IBM Office Architecture - DIA, SNADS) • Configuration, session, and management services	**Application layer** • User access to lower functions • Semantic changes between applications	**Application Layer** • ISO FTAM (DP) 8571 File Transfer Protocol • Manufacturing Messaging Format Standard (MMFS) • Common Application Service Elements (CASE)
Presentation Services • Representation of data (application, end user, systems) • Program-to-program protocols • Conversation-level communication between transaction programs	**Presentation Layer** • Representation of user or system data • Conversions and code translation (printers; ASCII/EBCDIC)	**Presentation Layer** NULL (ASCII and Binary Encoding)
Data flow control • Flow control for LU-LU sessions • Protocols, sequence numbers, request/response correlation	**Session layer** • Mechanisms for structuring the interaction between applications and/or devices	**Session Layer** ISO Session (IS) 8372 Basic Combined Subset and Session Kernel, Full Duplex
Transmission Control • Transmission resource control • Verifies sequence numbers • Manages session level pacing	**Transport layer** • End-to-end data transfer (transparent, reliable)	**Transport Layer** ISO Transport (IS) 8073 Class 4
Path Control • Message routing protocols • SNI protocols	**Network layer** • Network addressing and routing • Message unit segmenting, blocking, and sequencing	**Network Layer** ISO Internet (DIS) 8473 Connectionless and for X.25 – Subnetwork Dependent Convergence Protocol (SNDCP)

SNA	IEEE 802	OSI	MAP	Ethernet
Data link control • Link level flow control and error recovery • Physical link message transfer protocols	**Data link control layer** • LLC sublayer • MAC sublayer -CSMA/CD -Token-passing bus -Token-passing ring	**Data link layer** • Functions and protocols to transfer data between network entities • Detect (correct) errors in physical layer	**Data Link Layer** ISO Logical Link Control (DIS) 8802/2 (IEEE 802.2) Type 1, Class 1	**Data Link Layer** • Control information allowing for transfer of data between devices on the network • Link management
Physical control • Transmission media interface • Electrical characteristics for attachment physical connections	**Physical layer** • CSMA/CD media • Token-passing bus media • Token-passing ring media (IBM Cabling System)	**Physical layer** • Physical transmission on communications link • Mechanical, electrical, functional, procedural standards to access the physical medium	**Physical Layer** ISO Token Passing Bus (DIS) 8802/4 (IEEE 802.4) Token Passing Bus Media Access Control	**Physical Layer** • Data encoding • Channel access

Each layer of a reference model is assigned certain tasks in the operation of a network. The tasks are performed by the programs, microcode, and circuitry in network stations, and by the components and media that form the network.

The reference models define the protocols and interfaces required to accomplish the tasks in each layer and to exchange information with the other layers.

Interface A set of verbs or commands and a control block structure through which to express them.

The verbs or commands indicate the tasks requested and convey parameters, identification, and instructions needed to accomplish the tasks.

Protocol A set of rules for the sequencing and interaction of behavior and events which must occur to accomplish the tasks requested by a verb or command.

Support programs, operating systems, subsystems, application programs, and microcode use:

- The verbs, commands, and control blocks to initiate the tasks assigned to each layer of the reference models
- The protocol rules to execute the verbs or commands; that is, to perform the sequence of events and behaviors required to accomplish the requested tasks.

Although it varies with each network and with each reference model, typically:

- Application programs and application programming interfaces (APIs) provide the functions to accomplish the tasks of the Application and Presentation layers, including
  - User interfaces such as panels, menus, and key functions
  - Printer and graphics code sets, character fonts, and character conversion
- Operating systems and interface programs handle the tasks of the middle three layers, including
  - Establishment, management, and termination of sessions or conversations between network users
  - Management of program and device resources
- Adapter microcode, support programs, and the physical network transmission media accomplish the tasks of the physical and data link layers, including
  - Actual physical transfer of data from one device to another on the network
  - Detecting and presenting network status and error information.

Communication between two devices on a network can occur when programs are loaded and running in the correct combination and sequence in each device. The programs must use the same protocols and interfaces, or must provide conversion between different protocols and interfaces.

Some standard protocols and interfaces have been developed for use in LANs. Some of the protocols and interfaces that were originally written for WANs have been adapted to use on LANs and to allow communication between the different types of networks. "Protocols and Interfaces" on page 1-19 describes some of the protocols and interfaces used on IBM LANs.

Architecture and Network Administration

As network administrator, your main concern with architecture reference models is to make sure that the correct combination and sequence of programs run in each device to provide the required protocols and interfaces for network communication. Some knowledge of the functions of the layers can also help in problem isolation on the network.

A detailed understanding of the functioning of layers, various protocols, and interfaces is necessary only to those who need to write programs and interfaces that are used on the network with or instead of purchased programs.

Protocols and Interfaces

Each reference model defines one or more protocols and interfaces for the accomplishment of the tasks assigned to layers of the model.

In a set of standards for LANs, the IEEE 802 Project committees define two layers of protocols and interfaces, and describe the interface between the data link control layer and the network layer:

- IEEE 802.1 — Higher Level Interface (overview, architecture, addressing, internetworking, and network management) Standard
- IEEE 802.2 — Logical Link Control
- IEEE 802.3 — CSMA/CD Access Method and Physical Layer Specifications
- IEEE 802.4 — Token-Passing Bus Access Method and Physical Layer Specifications
- IEEE 802.5 — Token-Passing Ring Access Method and Physical Layer Specifications.

The IEEE 802 Data Link Control Layer

The data link control (DLC) layer of the IEEE 802 Reference Model provides the protocols and interfaces required to:

- Attach a device to the network and remove a device from the network
- Send information onto the network and receive information from the network
- Exchange data and control information with the higher level interfaces and protocols that support network application programs.

The DLC layer is divided into two sublayers:

- Logical link control
- Medium access control.

The Logical Link Control Sublayer

The logical link control (LLC) sublayer of DLC controls and schedules the exchange of message units between two devices over the network.

For sequential *connection-oriented* data transfer, LLC uses sets of resources and data link protocols called *link stations* to:

- Transfer message units in the correct sequence
- Acknowledge to the sender that message units were received correctly
- Retransmit message units if errors occurred during transmission.

For non-sequential *connectionless* data transfer, LLC provides a user datagram service for broadcast and datagram message units. Message receipt is not acknowledged and no transmission error recovery is provided.

The Medium Access Control Sublayer

The medium access control (MAC) sublayer of DLC controls routing of information between LLC and the physical network. MAC protocol functions include:

- Adapter address recognition
- Copying of message units from the physical network
- Message unit type and format recognition

- Message unit verification and status generation
- Routing of message units within the device for processing
- Physical medium access method management
- LAN segment and adapter status reporting.

The MAC sublayer contains the protocols for the media access methods used by LANs. IBM has implemented the token-passing ring method and a proprietary version of the CSMA/CD method in its LANs. (See "Media Access Methods" on page 1-13.)

Network Adapter Support

IBM LAN adapters provide two levels of communication with support programs and application programs:

- The **direct interface** defines a set of commands used by programs to handle:
  - Basic adapter functions (the ability to open and close an adapter, obtain error status, and set addresses, for example)
  - Transmission of frames directly without LLC protocol assistance.
- The **DLC interface** defines command control blocks (CCBs) that specify commands, parameters, and control information for the two types of communication provided by the LLC sublayer:
  - Connectionless communication (through the DLC service access point interface) between devices, providing no guarantee of delivery. These are primarily datagram and broadcast messages.
  - Connection-oriented services (through the DLC station interface) using LLC protocol. This is reliable data transfer, with acknowledgment and retransmission if desired.

Network adapter hardware and microcode implement functions defined in the physical layer and the MAC sublayer. Adapter microcode and adapter support software provide MAC sublayer and LLC sublayer functions.

Application programs can be written to communicate directly with network adapters. However, the use of adapter support programs can free the application program from such responsibilities as handling basic adapter functions, moving data between computer memory and adapter shared random access memory (RAM), and handling interrupts to transfer processing control between the adapter and the device.

The IEEE 802 Physical Layer

The physical layer in IBM LANs consists of cable, cable connection points, and physical circuitry used to:

- Connect a device to the network
- Encode, transmit, and react to signals on the network
- Provide the master clock for network timing requirements
- Provide the phantom circuit for network attachment voltage.

Higher Layer Protocols and Interfaces

The IEEE 802 Reference Model supports the use of a number of different higher layer protocols and interfaces. Some were developed for LANs. Others are adaptations of protocols and interfaces used on WANs or for specific devices. The higher layer protocols and interfaces supported by IBM LANs are described in the following section.

NETBIOS

The Network Basic Input/Output System (NETBIOS) interface is a message interface used on LANs to provide message, print server, and file server functions.

The following products provide NETBIOS interface support for programs that run in IBM LAN workstations:

- IBM LAN Support Program
- IBM OS/2 Extended Edition.

NETBIOS control block and command formats, contents, and sequences are discussed in the *IBM Local Area Network Technical Reference*.

SNA

Systems Network Architecture (SNA) supports three types of data link control protocols:

- System/370 or System/390* data channels

  Data channels are direct physical connections between two hosts or between a host and a device.

- Synchronous Data Link Control (SDLC)

  SDLC is a set of data link protocols that:

  - Conform to subsets of the Advanced Data Communication Control Procedures (ADCCP) of the American National Standards Institute (ANSI) and High-level Data Link Control (HDLC) of the ISO.
  - Manage synchronous, code-transparent, serial-by-bit information transfer over a *link connection* independently of the type of physical link.

    A link connection is the physical link between two devices. The configuration of the link connection may be point-to-point, multipoint, or loop. Transmission exchanges may be duplex or half-duplex over switched or nonswitched links.

  Telephone lines, microwave links, and other voice-quality communication media can use SDLC protocols.

- IEEE 802.2 DLC connection-oriented data transmission

  SNA applications on the IBM Token-Ring Network use the error recovery sequencing, and flow control of the LLC sublayer connection-oriented data transfer.

NCP Network Token-Ring Interface (NTRI)

The Network Control Program (NCP) contains support to allow the IBM 3725, 3720, and 3745 Communications Controllers to attach to the IBM Token-Ring Network. The NCP NTRI supports the exchange of data between application programs on the IBM Token-Ring Network and those in an SNA host computer.

APPC

Advanced program-to-program communications (APPC) describes the protocols used by programs in separate hosts or workstations to communicate with each other in the execution of a unit of processing called a *transaction*.

Versions of APPC for several IBM hosts and workstations provide a common API to transaction programs using the SNA logical unit (LU) 6.2 program-to-program interface.

Device Emulation

Device emulation allows one type of device to function as though it were another type of device.

IBM LAN workstations can use emulation adapters and software to emulate functions of terminals, displays, and controllers. The workstations can run application programs originally written to run in a host to which such terminals, displays, and controllers are connected. Users of the workstations can initiate and conduct communication between the workstation application programs and application programs in such a host. The host may access the LAN through a direct connection to the network or through connection to an intermediary network device (such as a controller or a workstation emulating a controller).

TCP/IP

Transmission Control Protocol/Internet Protocol (TCP/IP) is a set of telecommunication standards introduced by the U.S. Department of Defense. Because TCP/IP has been implemented by IBM and many other companies, it provides a common interconnection to link a variety of different products. TCP/IP, when used in an IBM virtual machine (VM) environment, provides communication between hosts and workstations on several LANs, including the IBM PC Network Broadband, the IBM Token-Ring Network, and Ethernet.

X.25 Packet Switching

X.25 packet switching is a set of protocols that defines the interface between data terminal equipment and packet switching networks. Packet switching routes and transfers data by means of addressed packets so that a circuit is occupied only during transmission of a packet. Upon completion of the transmission, the channel is available for the transfer of other packets.

Asynchronous Communication

Asynchronous communication protocols allow LAN communication application programs to communicate with remote non-SNA application programs and devices, including:

- Information services
- ASCII host computers
- ASCII terminals
- Workstations not directly connected to the LAN
- Devices attached to a ROLM** computerized branch exchange (CBX).

Asynchronous communication protocols used on IBM LANs include:

- The Asynchronous Communication Server Protocol

  LAN communication applications can use the Asynchronous Communication Server Protocol to communicate with a server on the network, through which connections are made to devices and applications not directly connected to the network.

- Enhanced BIOS Interface (EBI)

  In an IBM personal computer, the Basic Input/Output System (BIOS) is microcode that

  - Controls basic hardware operations such as interactions with diskette drives, fixed disk drives, and the keyboard
  - Allows the user to write programs and add or remove devices without concern for characteristics such as device address
  - Can contain device or adapter diagnostic tests that execute each time the device power is turned on or the device is reset
  - Can control the remote loading of programs and files from the memory or disk of one device into the memory of another device (Remote Program Load).

  EBI provides an enhancement to the BIOS interrupt X'14' service and an interrupt handler for serial asynchronous communication lines. Applications written to use the BIOS interrupt X'14' can use EBI to communicate with and through a communication server on the network.

LAN communication application programs and remote application programs must use compatible protocols in their communications.

Non-IBM Networks

IBM workstations and hosts can use combinations of adapters, attachment features, and programs to communicate with some non-IBM LANs that implement OSI or Project 802 protocols and interfaces. Such implementations include:

- Manufacturing Automation Protocol (MAP)

  MAP is a seven-layer architecture based on the OSI reference model. MAP uses a broadband token-passing bus to accommodate various manufacturing environments. The MAP model separates application programs tasks from communications tasks, and assigns the communications tasks to the seven layers of the model.

  When running in an IBM 8232, the IBM MAP LAN Channel Support Program enables communication between a host computer and a MAP 2.1 network.

  The IBM Series/1 can be an Application Server or Communication Server on a MAP network, to provide messaging, file server, network management, and host communication functions.

  The IBM 3172 Interconnect Controller can connect to a MAP network to provide communication between a MAP network and an IBM host.

  For more information about MAP, see Chapter 5.

- Ethernet/IEEE 802.3

  Ethernet and IEEE 802.3 LANs are baseband bus networks that use CSMA/CD to access the bus. IBM LAN products that connect to or communicate with Ethernet/IEEE 802.3 networks include:

  - IBM LAN Channel Support Program (IBM 8232)
  - TCP/IP
  - IBM RT PC, running Advanced Interactive Executive* (AIX*) and SNA application programs
  - IBM Local Area Network Support Program, Version 1.2
  - IBM 8209 LAN Bridge.

  For more information about Ethernet/IEEE 802.3 LANs, see Chapter 6.

IBM LAN Network Addressing

Just as we use our names and mailing addresses to identify us to the postal service when we send and receive letters, the programs and adapters that use a LAN must be able to identify each other in order to communicate and exchange information.

There are two major categories of addressing in LANs:

Adapter addresses identify each unique adapter or groups of adapters on the network.

Names or addresses identify application programs, support programs, and interfaces to each other on the network.

Network Adapter Addresses

Communication between adapters on an IBM LAN requires that each adapter can be recognized by a unique 12-digit hexadecimal address.

Most adapters used in stations on the network have a 12-digit hexadecimal *universally administered* address that is permanently encoded in the adapter's microcode when it is manufactured. The universally administered address can be overridden by a 12-digit hexadecimal *locally administered* address that you assign.

Some types of network adapters and attachment features do not have universally administered addresses. For those adapters, you need to assign a unique locally administered address to each adapter. The format you must use may contain fewer than 12 hexadecimal digits, or decimal digits only, or some other character pattern. Other adapters that communicate with an adapter requiring a specific address format may also need to have locally administered addresses assigned that are compatible with that specific format. A support program or the adapter microcode will convert the character pattern to 12 hexadecimal digits for use on the network.

The documentation packaged with devices, adapters, and programs explains the address formats and values used by and required for each adapter.[1]

[1] The universally administered address is referred to in IBM LAN publications by the following terms: the permanent address, the permanent node address, the local node address, the node address, the individual address, the specific address, the adapter ring address, or the "burned-in" address. The locally administered address may be referred to as the local node address, the node address, or the individual address.

Adapter Address Formats

In addition to universally and locally administered (individual) addresses, most network adapters also support the use of group addresses, functional addresses, and broadcast addresses. This section describes the purpose and format of each type of address.

Universally Administered Addresses

A universally administered address is permanently encoded in the microcode on an adapter when it is manufactured. Blocks of these addresses are assigned to each manufacturer by the IEEE; each address in a block contains a block identification code. The manufacturer is responsible for assigning an address from one of those blocks to each adapter, and ensuring that the address on each adapter is unique. Universally administered addresses consist of 12 hexadecimal digits.

The "Block identifier" field contains the block identification code assigned to the block of addresses by the IEEE.

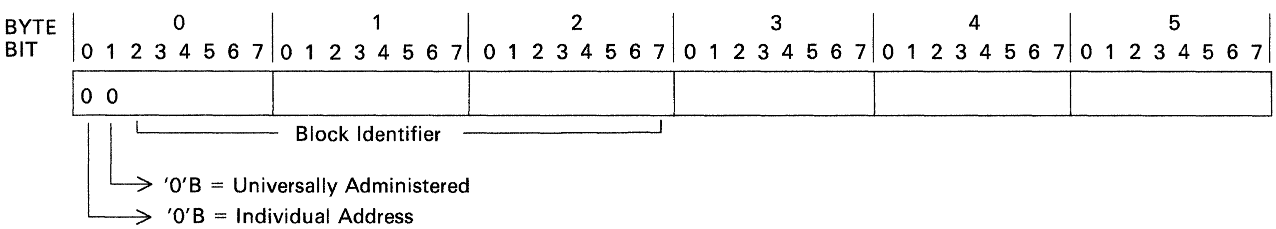

Figure 1-4. Universally Administered Address Format

Locally Administered Addresses

Most network adapters allow you to assign your own 12-digit hexadecimal locally administered address to override the universally administered address encoded on an adapter. You must make sure that each locally administered address you assign is unique in the network.

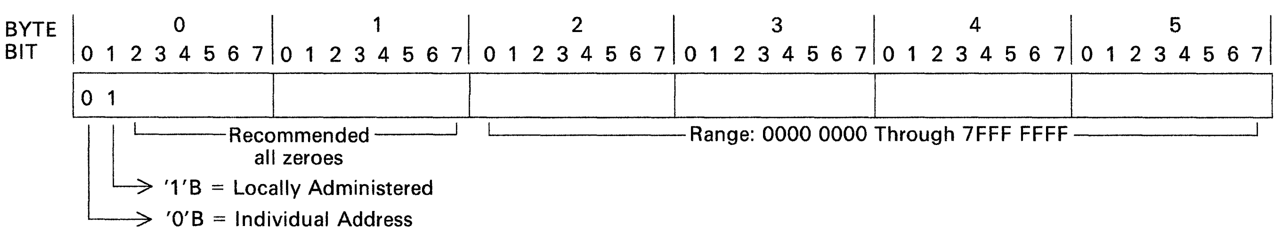

Figure 1-5. Locally Administered Address Format

The 12-digit locally administered addresses for IBM LAN adapters can be in the range X'4000 0000 0000' through X'4000 7FFF FFFF', although some devices and application programs limit the addresses they can use to a smaller range (for example, only decimal digits, making the highest valid value X'4000 7999 9999').

Some network adapters and attachment features allow or require you to specify locally administered addresses that do not contain 12 hexadecimal digits. The formats and ranges of these addresses vary depending on the programs and adapters that use them. These addresses are generally used by devices and programs that were not originally designed for use by IBM LANs, but have enhancements added to allow them to connect to LANs. An address in the format and range originally used by the programs in a device is usually assigned, and a conversion occurs to make the address compatible with other LAN addresses. For example, if an 8-character alphanumeric address was originally assigned, the use of that address on a LAN may require that the 8 characters be restricted to hexadecimal digits in the range X'0000 0000' through X'7FFF FFFF'. This allows 4000 to be appended to the front of the 8 characters to create a 12-digit locally administered address.

The use of a locally administered address to override the universally administered adapter address may be indicated to an adapter in several ways, including:

- As a parameter in the command used to load adapter support code
- As a parameter in a configuration file read by a program as it is loaded
- In a command sent to the adapter by an application program or support program.

You might choose to use locally administered addresses to more easily:

- Identify adapters, by assigning sequential values to related groups of adapters
- Identify use of a device or an application program, by assigning values that have significance in your establishment (such as location, cabling, user, or application program identifiers)
- Associate names and addresses on the network, by assigning compatible values to the locally administered address and to the name or address used to identify an application program, support program, or interface on the network
- Replace adapters, without having to modify programs or rerun system or subsystem generations for programs that recognize adapter addresses.

The documentation packaged with each adapter, program, or interface should indicate whether locally administered adapter addresses can be used by the program or interface.

Group Addresses

LAN adapters that support group addresses, let a program or interface send a single *broadcast* or *datagram* message that will be received by all attaching devices having the same group address. The same message does not have to be sent to each adapter individually.

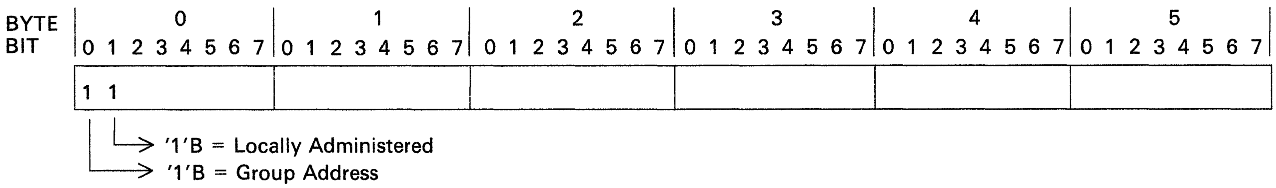

Figure 1-6. Group Address Format

Functional Addresses

A functional address is a special group address that allows:

- Programs and interfaces to request a particular service from another program or interface
- The adapter used by a providing program or interface to recognize the request for the service.

Programs and interfaces written for LANs enable the functional address on the adapter they are using to indicate the services they can provide to other programs and interfaces on the network. Programs and interfaces wanting to use those services specify the appropriate functional address in the requesting frame, instead of a specific adapter address. Any adapter on the LAN segment that can provide the service will read the frame, recognize the address, and pass the frame to the program or interface providing the service.

The functional address contains a variable bit pattern, with each bit representing a different service. Each provider of a service can set the bit assigned to that service, leaving unchanged the bits that have already been enabled by other providers of services in the same device. Some bits (functional addresses) are permanently assigned to certain services provided by programs and interfaces that you can purchase. Twelve bits are available for assignment by the programs and interfaces you might write.

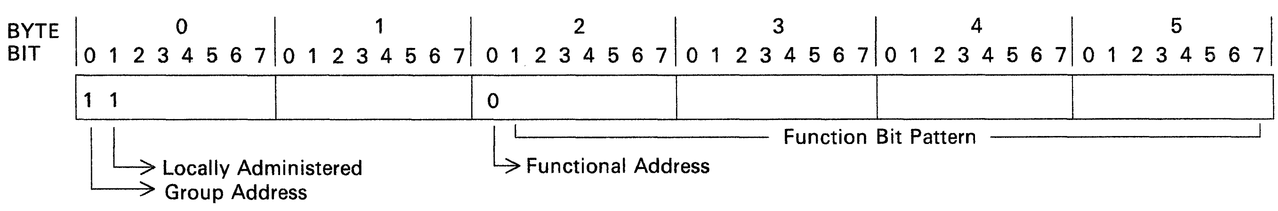

Figure 1-7. Functional Address Format

The *IBM Token-Ring Network Architecture Reference* and the *IBM Local Area Network Technical Reference* explain the use, format, and bit assignments of functional addresses.

Names and Addresses

Most application programs, support programs, and interfaces are identified for communication and data exchange by means of one or more assigned names or addresses.

Communication between two application programs on a network occurs as follows:

1. The sending application program prepares a message for the receiving application program, containing the receiver's name or address.
2. The sender passes the message, usually through a support program or interface, to its adapter.
3. The support program or interface and the adapter associate the receiver's name or address with the address of the receiver's adapter.
4. The sender's adapter sends the message around the network to the receiver's adapter.
5. The receiver's adapter and support programs or interfaces determine the receiving application program's name or address from the message.
6. The receiver's adapter passes the message to the receiving application program.

Thus, the application program does not usually need to put adapter addresses in its messages. One of the functions of the support programs and interfaces is to associate an adapter address with a sending or receiving application program.

Generally, each program or interface contains a table or list of:

- The name or names by which it and its functions or services are identified by other programs and interfaces on the network
- The name or names by which it can identify other programs and interfaces on the network, and their functions or services.

Most names can be recognizable words or combinations of letters and numbers. Some programs can use the device's network adapter address as an identifying name. Other programs require names of a specific format or convention, which is different from adapter addresses. A table or list is also used to correlate a program name with the address of the adapter the program uses to communicate on the network. Many of these programs or interfaces provide a function or file with which you assign the required names to create the lists or tables.

You must determine from the documentation packaged with each program or interface the required format for the names and addresses, and how to assign them. As you determine the types of addresses to be used in the network, you must make sure that addresses are compatible between the communicating programs and interfaces:

- On the same LAN segment
- Across connected LAN segments
- Between LAN segments and other types of networks.

Programs and interfaces that allow communication with other types of networks particularly need careful consideration, so that the names and addresses assigned are compatible on both networks.

Ethernet Addressing

Ethernet provides for universally administered, locally administered, network-specific, functional, and multicast addressing. Universally administered addressing is described in "IBM LAN Network Addressing" on page 1-25.

Ethernet Universally Administered Adapter Addressing

The XEROX Corporation provides blocks of addresses for use in Ethernet adapters. Each Ethernet adapter has a unique 48-bit universally administered address assigned to it at the time of manufacture.

Ethernet specifies the use of 48-bit addresses. (IEEE 802.3 allows either 16-bit or 48-bit addresses.)

Ethernet Locally Administered Adapter Addresses

The IBM LAN Support Program, Version 1.2 and some network applications allow you to override the universally administered address with a locally administered address that you assign.

In communication with hosts and controllers through gateway workstations, there may be a requirement for adapter addresses to be assigned in a certain format or in a certain range of characters.

The documentation packaged with devices, adapters, and programs explains the address formats and values used by and required for each adapter.

Network-Specific Addressing

For local addressing, each station is assigned a unique number within the network. However, this local address could be the same as the local address for another station on another network. In the case of interconnected networks, a unique network identifier must be included.

Note: Ethernet does not specify how the 48 bits of the address are used. Network-specific addressing is possible, but the higher level network layers must implement it.

Ethernet Multicast Addressing

Ethernet supports the use of multicast addressing. A multicast address is associated with a group of stations. A multicast address is identified by the value 1 in the first bit of the address.

Stations have multicast mode either on or off. If it is on, the station accepts any frame with multicast addresses. As with network-specific addresses, it is the responsibility of higher level network layers to determine if the station is part of the group for a particular multicast address.

Broadcast Addressing

Ethernet supports broadcast addresses. An address consisting of all 1 bits is defined as the broadcast address. Frames containing the broadcast address are received by all stations.

Names and Addresses

One or more assigned names or addresses identify most application programs, support programs, and interfaces for communication and data exchange.

Most names can be recognizable words or combinations of letters and numbers. Some programs can use the device's network adapter address as an identifying name. Other programs require names of a specific format or convention, which is different from adapter addresses.

Support programs and interfaces often use a table or list to associate an adapter address with a sending or receiving application program name or address. Many of these programs or interfaces provide a function or file with which you assign the required names to create the lists or tables.

You must determine from the documentation packaged with each program or interface the required format for the names and addresses, and how to assign them.

MAP Addressing

Since a single universal addressing standard does not exist, MAP has adopted an approach allowing the use of different address formats. The MAP address structure is shown in Figure 1-8. The first byte of a MAP address is a value that identifies the particular format used for the address. The network ID portion identifies a domain or area. The domain or area can consist of a collection of networks. The primary subnet ID in combination with the network ID identifies the specific network. The end system address portion identifies a process communicating at the network level on a particular device. For a network implementing the IEEE 802.2 LLC standard, this part of the address consists of the MAC address, the link station identifier, and a network user identifier.

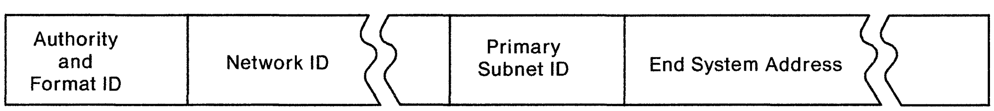

Figure 1-8. MAP Address Format

Network Management

Every station that connects directly to a LAN must have the capability to support network protocols and participate in network control and management. There is no built-in central point of control for a LAN or segment. A network user or administrator must depend on the programs and operating systems running in each network station to detect and report station, program, adapter, and network status and error conditions.

Workstations that have a display and hosts that have a display or console can present messages and codes to indicate status and errors. Devices that cannot communicate so easily with a user or operator (for example, a controller) usually pass their information to a program in a host or workstation that does have a display or console for presentation.

Network adapters exchange information about their own status and the status of the network. The application programs and operating systems running in each station collect and report:

- Information about their own operating status and error conditions
- The operating status of the device in which they are running
- Status and error information received from network adapters in the stations.

IBM has developed some network application programs to help you manage LANs more easily and efficiently. Although these programs do not provide status and error information about the programs running in other stations or about the devices using the network (other than their own), they provide a more centralized means of obtaining:

- Network and adapter status for one or multiple LAN segments
- Logs, traces, and error indicators to use in network problem isolation and resolution
- Performance and utilization information to help in evaluating network traffic flow and distribution.

Network Management Programs

Most IBM network management products provide one or more of the following capabilities:

- Collect, log, and display network and adapter status and error information
- Execute operator commands to remove malfunctioning adapters from the network
- Report network and adapter status to network management functions at a host.

Some LAN management programs collect information only for the LAN segment to which they are connected. Others can provide information for multiple LAN segments connected by bridging products. Most IBM bridging products collect and display status and error information for the bridging station, the bridging product, and the two LAN segments connected by the product. Most IBM bridging products can pass status and error information to LAN management programs with which a communication link has been established. For LAN segments that contain connections to System/370 or System/390 hosts, some LAN management programs can send *alerts* to the host, if the host is running the NetView* program. An alert is an indication of a problem or an impending condition that, if not corrected, will soon result in a problem on a portion of the network.

Trace, Performance, and Utilization

Some IBM bridging products:

- Provide performance counts and statistics to help you evaluate the traffic flow through a bridge
- Report status, performance, and error information to network manager programs.

Other IBM programs include functions to:

- Trace and count frames and bytes sent over a LAN segment
- Present LAN segment utilization in graphs, panels, or tables.

Network and Adapter Status

Network adapters exchange information about their own status and the status of the network, which can include:

- Notification that an adapter has become active on the network
- Notification that an adapter has ceased being active on the network
- Detection by one adapter of a possible problem with an active adapter adjacent to it on the network
- Detection by an adapter of a network error condition (such as a malfunctioning hardware component or excessive soft errors)
- The condition of the signal carried by the network physical medium.

The network and adapter status differ slightly for each type of LAN. Chapter 2, Chapter 3, and Chapter 4 describe the status presented for each type of IBM LAN. Chapter 5 and Chapter 6 describe the status presented for some non-IBM LANs.

Problem Determination and Resolution

Recognizing, isolating, and resolving problems on a LAN involves:

- Determining that there is a problem

  Indications of problems on a LAN can come from four main sources:

  - A network user report that a device or application program is no longer working, is not working normally, or is indicating an error condition.
  - A status or error indicator from a LAN manager program or other network application program (such as a bridging product).
  - A status or error indicator from a host network management tool and call to you from the host operator.
  - Analysis of trace, performance, and utilization information.

- Determining the nature of the problem

  Reported symptoms and status and error information will help you determine the type or nature of the problem. The nature of the problem usually indicates the tools and procedures to use to isolate and resolve the problem.

  You will need to determine:

  - Whether the problem is a hard or soft error, a hardware or software error, or a user error.
  - What portion and component of the network is having the problem; a user, a program, a device, a network adapter, or another network component.

- Using the required tools and procedures to resolve the problem

  - Users may require instructions or other assistance in use of programs and devices on the network.
  - Publications packaged with programs, devices, and network components describe actions and procedures to use to correct malfunctions.
  - Diagnostic tests and trace tools help you isolate a problem to the failing hardware or software.
  - Network documentation and problem determination procedures help you locate and repair or replace a failing network hardware component.
  - Network manager programs, network application programs, and user application programs can provide a first indication of a problem and additional information helpful in resolving the problem.

The following chapters describe problem determination and resolution in more detail for each LAN and in relation to the tasks of network administration:

- Chapter 2, "IBM Token-Ring Network"
- Chapter 3, "IBM PC Network Broadband"
- Chapter 4, "IBM PC Network Baseband"
- Chapter 5, "Ethernet"
- Chapter 6, "MAP (Manufacturing Automation Protocol)"
- Chapter 11, "Network Problem Analysis and Resolution."

Interconnection

LAN technology provides for communication between:

- Devices on the same LAN segment, over the network itself
- Devices on different LAN segments, through bridging products
- Devices on the LAN and devices on another type of network, through gateways
- Devices on the network and devices not directly connected to the network, through communication servers and other remote connections.

Bridging Products

Bridge

- Two networks of the same or similar architecture
- Two LAN segments that use the same LLC protocol, but may use the same or different MAC protocols.

Several IBM bridging products are available that connect two LAN segments, either two of the same type or one each of two different types.

The functions provided by bridging products include:

- Forwarding frames from devices on each LAN segment to the devices on the other LAN segment
- Collecting and displaying status and error information about the bridging product and about the two connected LAN segments
- Passing product and LAN segment status and error information to network manager programs
- Providing traffic flow and performance information for traffic evaluation and problem resolution.

Chapter 15 describes IBM bridging products, including network considerations for selecting bridge configuration parameter values. Chapter 8, "Network Planning" discusses the placement of bridging products in a LAN.

Gateways

Gateway A functional unit that connects:

- Networks that use different network architecture
- A LAN with another network that uses different protocols.

Gateway connections from IBM LANs are usually to WANs that use SNA or to asynchronous or ASCII hosts. Some use the NETBIOS interface; some use device emulation. IBM LAN gateway connections are usually provided as a function or feature of a program running in the gateway device. The gateway connection can be a direct connection between the LAN device and the host or other network, or the gateway connection can include a remote connection over a telecommunications link or public switched network.

Chapter 16 describes programs and devices that provide gateway functions on IBM LANs.

Remote Connections

Remote Connection A device on a LAN that provides a connection to:

- A device that cannot connect directly to the network because of
  - An interface that is incompatible with the network
  - Incapability to support network connection and protocols.
- A device that is geographically unable to connect directly to the network, but can connect over a remote transmission link.

IBM communication servers provide communication between workstations on a LAN and "remote" devices that cannot connect directly to the network. The remote devices are usually:

- Asynchronous devices
- ASCII hosts
- Other workstations that are not physically close enough to connect to the network.

The remote devices can connect directly to the communication server device or can communicate with the server over a transmission link or public switched network. Most IBM communication servers support communication between applications that use the NETBIOS interface.

Chapter 16 describes IBM LAN programs that provide communication server functions.

Network Software

The software used in devices that connect to a LAN can be described in three major categories:

- Application programs
- Operating systems and subsystems
- Support programs and interfaces.

Your primary concerns with network software are to:

- Select the correct combination of programs for each device to accomplish the required work and provide the required protocols and interfaces
- Install the programs in each device in the correct sequence
- Specify the addresses, names, and parameters required for operation and communication.

Chapter 8 and Chapter 9 discuss software selection and installation.

Application Programs

Application programs accomplish the work done on the network by performing such tasks as word and text processing, scientific calculation, graphic illustration, database entry and management, and data inquiry and presentation.

Application programs can also provide services on the network such as:

- Network management
- Bridging between two LAN segments
- Messaging, server, and resource-sharing functions
- Network status and error information reporting.

Chapter 14, Chapter 15, and Chapter 16 describe application programs that provide network services.

Operating Systems and Subsystems

Operating systems and subsystems:

- Control the operation of devices
- Control the operation of devices connected peripherally to the device containing the operating system or subsystem
- Manage device and program resources
- Provide error and status information.

Chapter 17 describes operating systems and subsystems that run in devices connected directly to LANs and in devices accessed through gateways and remote connections.

Support Programs and Interfaces

These programs can:

- Provide simplified communication between devices and application programs that
  - Use interfaces and protocols to exchange data rather than the exchange being done directly through the adapters
  - Do not use the same protocol or interface.
- Relieve application programs and operating systems of the burden of handling basic adapter functions and communication directly with an adapter.

Chapter 12 describes programs that provide network device and adapter support.

Chapter 2. IBM Token-Ring Network

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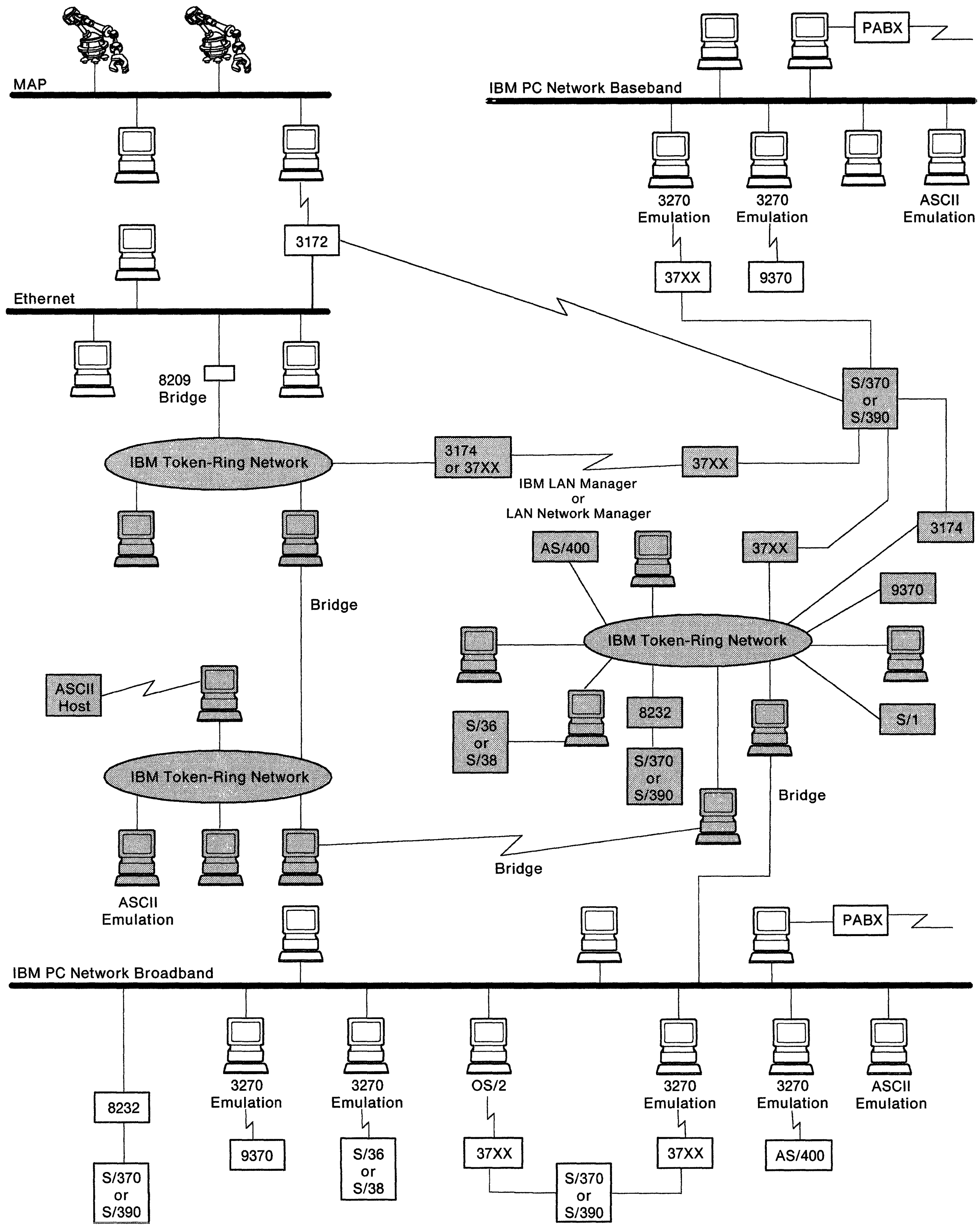

Figure 2-1. The IBM Token-Ring Network Portion of a Composite LAN

Overview of the IBM Token-Ring Network

The IBM Token-Ring Network uses a star-wired ring topology. The stations physically connect to access units that electrically connect the stations together in a logical ring. The access units act as switching and concentration points, allowing stations logically to attach to and remove from the ring without disrupting ring operation. The access units can be connected together to form larger single rings up to the following maximum sizes:

- Up to 260 attaching devices per ring when permanently installed IBM Cabling System cables are used
- Up to 96 attaching devices per ring when only patch cables are used in small networks (instead of permanent building wiring)
- Up to 72 attaching devices per ring operating at 4 Mbps that contains telephone twisted-pair cables.

For more information, consult the *IBM Token-Ring Network Introduction and Planning Guide*.

Bridging products can be used to connect rings to each other and to buses to form larger networks. Figure 2-1 highlights the IBM Token-Ring Network portions of a composite LAN.

A device is attached to (is active on) the network when an application program running in the device directs the network adapter to send an electrical signal to the access unit to which the adapter is connected. The device is removed from the network (not active, but still physically connected by a cable to the access unit) when the application program directs the adapter to cease sending the electrical signal to the access unit.

Hardware Components

Cable connects attaching devices to access units and access units to one another. The IBM Token-Ring Network can use any of the cable types specified in the IBM Cabling System, including telephone twisted-pair media and optical fiber cables.

Access units allow devices to attach to a ring. Each IBM 8230 Token-Ring Network Controlled Access Unit connects up to 80 stations. Each IBM 8228 Multistation Access Unit connects up to eight stations. IBM 8230s and IBM 8228s can be connected together to form larger rings.

Network adapters are installed in attaching devices to enable the devices to communicate with one another on the network. Network adapters (and attachment features) provide the cable connector used to connect a station to an access unit, and control the station's transmission and receipt of information on the ring. Each station that directly connects to an access unit must have an adapter installed in it.

The type of adapters used and the adapter configuration parameter settings determine whether a ring transmits data at 4 or 16 Mbps. See "Network Adapters and Attachment Features" on page 2-5 for more about adapters and attachment features.

Software support programs, interfaces, operating systems, and subsystems provide functions such as:

- Protocol conversion
- Adapter or feature configuration
- Association between application program addressing and adapter or feature addressing
- Network access.

Part 3 of this manual describes support programs, interfaces, subsystems, and operating systems used by IBM Token-Ring Network attaching devices.

Remote Program Load (RPL) Modules can be installed by the user on workstation adapters to enable programs and files to be sent from one workstation and loaded into the memory of another workstation without the use of a disk or diskette at the receiving workstation. The user must write the programs that accomplish the sending and receiving of programs and files between the workstations.

Repeaters and converters increase the geographical coverage of the network.

- The IBM Token-Ring Network 8218 Copper Repeater compensates for cable and access unit attenuation by regenerating the signal on copper wire cables that connect access units (on 4-Mbps LAN segments only).
- The IBM Token-Ring Network 8219 Optical Fiber Repeater
  - Handles conversion between electrical and optical signals when optical fiber is used for long distances between access units (on 4-Mbps LAN segments only)
  - Compensates for optical fiber light signal attenuation.
- The IBM Token-Ring Network 8220 Optical Fiber Converter
  - Compensates for optical fiber light signal attenuation
  - Handles conversion between optical and electrical signals when optical fiber is used between access units on 4 and 16-Mbps LAN segments
  - Can sense signal loss in the optical fiber path and switch to a backup path without manual intervention
  - Has a universally administered address and can report status and error information to network manager programs.

Access Units

Devices connected to a Token-Ring Network must be connected in a logical ring. Although it is possible to connect the devices in a serial manner, wiring concentrators (called access units) allow a number of attaching devices access to the ring at a central point. Use of access units minimizes the distance around the ring when only a few attaching devices are in use. Use of access units also simplifies adding new devices, moving existing ones, or changing network configuration.

There are two kinds of access units:

- IBM 8228 Multistation Access Units
- IBM 8230 Controlled Access Units.

The IBM 8228 Token-Ring Network Multistation Access Unit allows up to eight devices to have access to a ring.

The IBM 8230 Token-Ring Network Controlled Access Unit:

- Can sense signal loss in the main circuit path and switch to a backup path without manual intervention
- Has three universally administered addresses and can report status and error information to network management programs
- Has optical fiber modules to allow for a mixture of copper and fiber cabling in the main ring path
- Supports copper and fiber optic cabling
- Is switchable between 4 and 16 Mbps
- Provides automatic error recovery resulting in less network downtime and quicker problem isolation and repair.

Network Adapters and Attachment Features

Each device that connects directly to an IBM Token-Ring Network must have a network adapter or attachment feature installed in it. Adapters plug into slots or positions in the attaching devices. IBM Token-Ring Network attaching devices and the adapters and attachment features used in them include those listed in Table 2-1 on page 2-6.

Most adapters provide:

- An interface to communicate with the ring
- A protocol handler to process information going to and coming from the ring
- An interface through which the computer and the adapter may share RAM and exchange processing control.

The IBM Token-Ring Network Busmaster Server Adapter/A requires:

- A user-written microcode loader
- A user-written adapter support interface.

Table 2-1. Some IBM Token-Ring Network Device and Adapter Combinations

Type of Device	Method of Attaching to Network
IBM Personal Computers IBM Personal System/2 computers with PC I/O Channel architecture IBM Industrial Computers IBM 8232 LAN Channel Station	IBM Token-Ring Network PC Adapter II IBM Token-Ring Network 16/4 Adapter
IBM Personal System/2 computers with Micro Channel* architecture Industrial Computers	IBM Token-Ring Network Adapter/A IBM Token-Ring Network 16/4 Adapter/A IBM Token-Ring Network 16/4 Busmaster Service Adapter/A
IBM RT PC IBM RISC System/6000	IBM Token-Ring Network RT PC Adapter
IBM 3172 Interconnect Controller	IBM 3172 Interconnect Controller Token-Ring Network 16/4 Adapter
IBM 3174 Establishment Controller	IBM Token-Ring Network 3270 Gateway Feature (Token-Ring Network adapter)
IBM 3720 Communications Controller	Token-Ring Interface Coupler (TIC)
IBM 3725 Communications Controller	Token-Ring Interface Coupler (TIC)
IBM 3745 Communications Controller	Token-Ring Adapter (TRA) Feature (Token-Ring Network adapter)
IBM System/36 or 38	S/36 or 38 LAN Attachment Feature (IBM Token-Ring Network PC Adapter II)
IBM AS/400	Integrated Token-Ring Network adapter
IBM 9370 Information System	IBM Token-Ring Network Subsystem Controller – Communication Processor Card (CPC) – Token-Ring Network adapter (1 only per CPC)
IBM Series/1	IBM Series/1 Token-Ring Interface Feature (Token-Ring Network adapter)

IBM Token-Ring Network Adapter Configuration Parameters

Hardware switches, jumpers, and software configuration parameters allow you to define or set configuration options for each adapter, in order to:

- Enable or disable adapter features and functions
- Assign values for adapter resource allocation
- Accommodate installation of multiple adapters in one device.

Workstation Adapters IBM Token-Ring Network adapters for workstations (personal computers) with PC/IO Channel architecture have switches that must be set before installing an adapter in a workstation. (The IBM Token-Ring Network RT PC Adapter has jumpers instead of switches.)**:** IBM Token-Ring Network adapters for workstations that use Micro Channel architecture do not have switches or jumpers. Modules copied from the adapter's Option Diskette to the computer's Reference Diskette provide a software configuration process after the adapter is installed in the computer.

The publications packaged with the adapters explain how to install each adapter, set its configuration parameters, and verify its operation.

Adapter diagnostic tests, support programs, and some network application programs display information indicating the result of setting the adapter switches and configuration parameters (such as the current adapter interrupt level), allowing you to verify the settings.

Workstation adapter configuration options and parameters include:

Primary/Alternate Adapter: If there are two network adapters installed in a computer, one is designated as the primary adapter and the other is the alternate adapter. The primary adapter is also referred to as adapter 0; the alternate adapter is adapter 1.

Some products and programs have specific requirements for an adapter being primary or alternate. For example, if an IBM PC Network adapter and an IBM Token-Ring Network adapter are installed in the same device to be used by the same application program, the IBM PC Network adapter must be the primary adapter and the IBM Token-Ring Network adapter must be the alternate adapter.

The device type, the networks to which the device can attach, and the number of adapters in the device, determine how to set the primary/alternate option for each network adapter in your network.

The publications for the computer, the adapter, and the application program contain requirements for setting the primary/alternate adapter option.

Interrupt Levels: There are several *interrupt levels* that the adapter, the computer, interfaces, support programs, and application programs use to transfer processing control from one to the other. The interrupt level to be used is set for each adapter.

IBM Token-Ring Network workstation adapters and support code can use interrupt levels 2, 3, 6, and 7 for the IBM Token-Ring Network Adapter 16/4 and Adapter II, and levels 2, 3, 10, and 11 for the IBM Token-Ring Network Adapter/As (the IBM Token-Ring Network RT PC Adapter can use levels 11 and 12).

Many application programs that use network adapters require the adapter to be set to a specific interrupt level (usually 2, 3, or 4). In choosing the interrupt level for each adapter in your network, you will need to consider the interrupt levels required and allowed for all the adapters installed in one device. For example:

- Printers frequently require level 7.
- Diskette drives use level 6; this level should not be used for other adapters.
- Emulation packages often require level 2. Level 2 cannot be used for an IBM Token-Ring Network adapter if it shares the computer with 3278-79 Emulation.

Remember that:

- Unless the adapters support interrupt sharing, no two adapters installed in a single device can use the same interrupt level
- Each adapter must use an allowed or required level.

See the publications for programs, interfaces, and adapters for information on allowed and required interrupt levels.

Read-Only Memory (ROM): The IBM Token-Ring Network adapters use an area in the computer's memory to locate adapter read-only memory (ROM).

Adapter switches or a Reference Diskette configuration parameter indicate to the computer the memory address the adapter will recognize as the beginning of its ROM. An address on an 8 KB or 16 KB boundary above X'A0000' is used for the start of adapter ROM.

X'CC000' is the recommended address for the primary adapter; X'DC000' is recommended for the alternate adapter. If other adapters in the device also require addresses for sections of computer memory, the ROM address for each adapter must be set so that no two adapters in the same device use the same computer memory address.

Publications packaged with the adapters and support programs should indicate the required and allowed addresses. The *Guide to Operations* manuals for adapters used in computers with PC I/O Channel architecture list valid addresses on 8 KB and 16 KB boundaries, and the addresses used by some other IBM personal computer products. The Personal System/2 computer Reference Diskette provides a list of valid ROM addresses for an Adapter/A.

Jumpers on the IBM Token-Ring Network RT PC adapter indicate which ROM (of two) to enable.

Shared RAM Size: The IBM Token-Ring Network 16/4 Adapter and 16/4 Adapter/A have up to 64 KB of random access memory (RAM). The IBM Token-Ring Network 16/4 Busmaster Server Adapter/A has 128 KB of RAM. Switches or software configuration parameters allow you to select an adapter RAM size of 8, 16, 32, or 64 KB.

The computer in which the adapter is installed allocates up to 128 KB of its memory for the collective use of all of its installed adapters. The adapter RAM size you select is mapped to the same memory size within 128 KB of computer memory, with one exception.

If you select a RAM size of 16 KB on a 16/4 adapter, the RAM paging adapter function is enabled. Adapter RAM is divided into four equal *pages* of 16 KB each (total of 64 KB). A pointer allows the computer to access one 16 KB page at a time. The pointer is updated each time the computer needs to access a different page.

The IBM LAN Support Program and IBM Operating System/2* Extended Edition 1.1 or higher (OS/2* EE 1.1 or higher) provide software support for RAM paging.

Adapter Data Rate: The IBM Token-Ring Network 16/4 Adapter and 16/4 Adapter/A can transmit data to the network at 4 or 16 Mbps. An adapter switch or software parameter indicates the data rate you select.

Every network adapter on a LAN segment must transmit data at the same rate. If 16/4 adapters are used on the same LAN segment with adapters that can transmit at only 4 Mbps, the 16/4 adapters must be set to transmit at 4 Mbps. If you have IBM 8230s in a 4-Mbps LAN segment, each IBM 8230 must be set at 4 Mbps.

When you set a 16/4 adapter to transmit at 16 Mbps, the Early Token Release adapter function is automatically enabled. (You can disable it through a support program parameter.) Early Token Release allows a station that has just transmitted a frame to release a new token without waiting for the acknowledged frame to return from the receiving station. Allowing one token and one or more frames to circulate on the network at one time increases network utilization and performance.

Host and Controller Adapters and Attachment Features

Controllers and host computers access an IBM Token-Ring Network in two ways:

- Direct attachment through a network adapter or attachment feature
- Connection through an intermediary device, such as a workstation, that contains a network adapter and a connection to the controller or host.

The adapter or attachment features in hosts and controllers are usually installed as the device is manufactured or inserted by a service person at the establishment. Adapter configuration options and parameters are usually set through either microcode or support program functions. Some host and controller adapters have a universally administered address; some do not. Most allow or require you to assign a locally administered adapter address during adapter configuration.

The hosts and controllers that access a LAN through a network workstation usually:

- Contain a feature that allows connection to the workstation
- Require corresponding support programs in the workstation and in the host or controller for interface and protocol support.

Chapter 12 describes support programs used for host and controller access to an IBM Token-Ring Network.

Data Transmission

The IBM Token-Ring Network:

- Transmits data at 4 or 16 Mbps, depending on the type of adapters used and software parameter settings
- Uses the baseband transmission technique
- Uses token-passing to access the transmission media.

On a 4-Mbps ring and on a 16-Mbps ring that is not using Early Token Release, token access operates as follows:

- An adapter with data to send on the network (the sender)
  - Receives the first available token
  - Adds the data and routing information to make a frame
  - Sends a copy of the updated frame out on the network.
- The frame travels to its destination. The receiving adapter
  - Copies the frame from the network
  - Updates the frame to indicate that the frame has been copied
  - Sends the frame back out on the network.
- The sender
  - Receives the frame
  - Removes the frame from the network
  - Releases a new free token on the network.

On a 4-Mbps LAN segment, there can be only one token or one frame on the network at a time. The sender cannot release the new token until the acknowledged frame is received.

On a 16-Mbps LAN segment, there can be one or more frames and one free token on the network at the same time.

Early Token Release is an adapter configuration option used only in 16-Mbps IBM Token-Ring Network segments. Early Token Release gives network adapters more frequent access to a free token by allowing one token and one or more frames to circulate on the network at once. The use of Early Token Release allows the sender to release a new token without waiting for the acknowledged frame to return.

In deciding whether to set Early Token Release on or off for the network adapters, consider the following:

- Each token contains a priority indicator. If a program requires more frequent access to tokens than other programs on the network, the program can indicate the required priority to its network adapter. The adapter then uses tokens that have a priority indicator equal to or lower than the program's required priority. The adapter follows a procedure for setting the priority indicator in the new tokens it releases so that adapters with lower priorities are not prevented from getting tokens.
- If all of the adapters on a LAN segment use Early Token Release, the priority process no longer functions normally (it is essentially disabled).
- If some but not all of the adapters on a LAN segment use Early Token Release, priority functioning is unpredictable.
- If there are programs on a LAN segment connected to a bridge, that **must** use a higher priority to acquire tokens more frequently than other programs, then Early Token Release must be set OFF for all adapters on the LAN segment (including the bridge adapters).
- If priority token access is not required by the programs on the LAN segment, then Early Token Release can be set ON for any adapters on the LAN segment.
- Though some programs written to run on the IBM Token-Ring Network do set a higher than normal priority (IBM bridging products do), most of these programs should function normally with Early Token Release active.

Transmission of Data on the Network

To use an attaching device to communicate on the network, the device must contain:

- An operating system or subsystem
- A network adapter

  Note: All IBM Token-Ring Network adapters on the same LAN segment must use the same data transmission rate.

- A cable to connect the adapter to the IBM Token-Ring Network through an access unit
- One or more application programs that can send and receive data on the network.
- A support program or interface that handles communication between the adapter and the application programs.

  Although application programs can be written to communicate directly with the adapter, most require a support program. Part 3 of this manual describes support programs and interfaces used on the IBM Token-Ring Network.

When the network adapter is instructed by an application program to "initialize" and "open," the adapter goes through a series of diagnostic tests before attempting to attach to the network. The diagnostic tests verify that:

- The adapter is operating correctly
- There is a cable between the attaching device and the access unit
- A test message sent along that cable can pass through the cable and return unchanged.

The "open" command tells the adapter to send a direct current signal to the access unit to which it is attached. This causes the attaching device to become an active part of the ring: receiving, monitoring, and retransmitting ring traffic.

To communicate on the network, a network adapter participates in the process of obtaining a token from the ring, changing the token to a frame containing control information and data, sending the frame out on the network, removing the acknowledged frame from the network, and generating a new token.

Network Architecture

The IBM Token-Ring Network architecture is an implementation of the logical link control (LLC) and medium access control (MAC) sublayers of the data link control (DLC) Layer of the Project 802 Reference Model, compatible with:

- *IEEE Standards for Token-Ring Networks: Logical Link Control*, ANSI/IEEE Std 802.2-1985 (ISO 8802-2)
- *IEEE Standards for Token-Ring Networks: Token-Ring Access Method*, ANSI/IEEE Std 802.5-1985 (ISO 8802-5).

The IBM Token-Ring Network implementation includes the two levels of communication with network adapters, although not all adapters use both levels or all functions of both levels:

- The direct interface, which provides
  - Basic adapter functions (the ability to open and close an adapter, obtain error status, and set addresses, for example)
  - Transmission of frames directly without LLC protocol assistance.
- The DLC interface, which provides
  - Connectionless communication between devices providing no guarantee of delivery (through the DLC Service Access Point interface). These are primarily datagram and broadcast messages.
  - Connection-oriented services using LLC protocol (through the DLC station interface). This is reliable data transfer, with acknowledgment and retransmission if desired.

Implementation of DLC and MAC protocols for the IBM Token-Ring Network is explained in the *IBM Token-Ring Network Architecture Reference*. The use of the DLC and direct interfaces and the DLC, LLC, and MAC protocols by IBM Token-Ring Network application and support programs for workstation adapters is described in the *IBM Local Area Network Technical Reference*.

The publications packaged with and related to adapters for hosts and controllers contain information about their use of IBM Token-Ring Network adapter interfaces and protocols.

Protocols and Interfaces

The IBM Token-Ring Network uses the MAC sublayer of Data Link Control protocol to control data flow, monitor ring conditions, and encapsulate and route data for devices attached to the physical ring. Token-passing is the method used for access to the physical medium.

To communicate over the network, the adapter in an attaching device must:

- Capture the token
- Convert the token to a *frame* by adding control information and the data to be transmitted
- Send the frame onto the physical medium to the intended receiver.

The frame may be either of two types:

- MAC frame

  MAC frames contain information about the status of an adapter or of the ring itself.

  Certain MAC frames may be received by the adapter and provided to the application program at the direct interface. Some MAC frames may be sent to the adapter for transmission on the ring using the direct interface of either an adapter support program or the adapter.

- Non-MAC frame.

  Some non-MAC frames contain data and messages that users transmit to one another.

  Some non-MAC frames contain DLC protocol-only information. Frames used with DLC operations are defined as LLC frames.

Higher Level Protocols and Interfaces

The IBM Token-Ring Network supports products that use all of the higher level protocols and interfaces described in "Higher Layer Protocols and Interfaces" on page 1-21.

NETBIOS

The Network Basic Input/Output System (NETBIOS) interface is used by applications on an IBM Token-Ring Network particularly for messaging, file server, and print server applications.

Device Emulation

Device emulation is used on the IBM Token-Ring Network for:

- Access to hosts and controllers that cannot connect directly to the network.
- Use of applications on the LAN that were originally written for devices other than workstations, and communication with such devices on other hosts or networks.

  Workstations using 3270 emulation can communicate with:

  - A System/370 or System/390 host through a connection to an IBM 3174 Establishment Controller or an IBM 3720, 3725, or 3745 Communications Controller.
  - An IBM 9370 host through a direct or remote host connection to the workstation, or through a controller connected to the host and to the workstation.
  - A System/36 or 38 host through a remote gateway connection to the host.

APPC
Advanced Program-to-Program Communication (APPC) provides a common Application Program Interface to transaction programs using the SNA LU 6.2 program-to-program interface.

Asynchronous Communication
Workstations on an IBM Token-Ring Network can function as asynchronous communication servers to connect LAN communication application programs and remote non-SNA application programs and devices.

SNA
Protocols and interfaces for SNA application programs on the IBM Token-Ring Network and in hosts and controllers that access the network are provided by:

- 3270 emulation
- APPC applications
- IBM Series/1 office server
- Network Token-Ring Interface (NTRI) for the IBM 3720, 3725, and 3745 Communications Controllers.

TCP/IP
Transmission Control Protocol/Internet Protocol (TCP/IP) is used in workstations and hosts with VM. The IBM 3172 Interconnect Controller provides direct channel connection between LANs and a host using VM. The IBM 8232 LAN Channel Station provides a direct channel connection between the IBM Token-Ring Network workstations and a host using TCP/IP with VM. The Advanced Interactive Executive program (AIX) provides TCP/IP support for the IBM RT PC.

Non-IBM Networks
The IBM Series/1 can be an Application Server or Communication Server on a MAP network and on an IBM Token-Ring Network to provide messaging, file server, network management, and host communication functions. The Series/1 support programs do not automatically provide bridging between the two networks. Applications must handle data transfer from each network to the Series/1, through the Series/1, and to the other network.

The IBM 3172 Interconnect Controller allows IBM System/370 or System/390 host processors to connect to processors from other equipment manufacturers attached to LANs. The connectivity is provided by supporting industry-standard communications protocols, including MAP 3.1 and Ethernet, and interconnections between IBM and DEC network protocols. The 3172 does not provide a bridging or routing function between the LANs or a direct channel-to-channel connection between the two hosts. Host communications must be over a LAN.

The IBM 8232 LAN Channel Station provides a direct channel connection to Ethernet and to the IBM Token-Ring Network. The IBM LAN Channel Support Program does not automatically provide bridging between the two networks. Applications on the networks and in the host connected to the IBM 8232 must handle data transfer from one network to the other.

The IBM 8209 LAN Bridge provides a connection between an IBM Token-Ring Network and an Ethernet Network.

Network Addressing

The IBM Token-Ring Network uses both major categories of LAN addressing described in "IBM LAN Network Addressing" on page 1-25:

Adapter addresses identify each unique adapter, groups of adapters, and functions provided by adapters on the network from one attaching device's adapter to another.

Names or addresses identify application programs, support programs, and interfaces to each other on the network.

Network Adapter Addresses

Adapters that communicate on an IBM Token-Ring Network must be identified on the network by a 12-digit hexadecimal adapter address.

IBM Token-Ring Network workstation adapters have a 12-digit hexadecimal universally administered address that is permanently encoded in the adapter's microcode when it is manufactured.

The IBM LAN Support Program and some network applications (including the IBM bridge programs) allow you to override the universally administered address with a locally administered address that you assign.

For hosts and controllers that connect directly to the IBM Token-Ring Network, some of their attachment features or adapters have universally administered addresses; some do not.

Host and controller attachment features that do not have a universally administered address require that you assign a locally administered adapter address during adapter configuration.

Some applications, hosts, and controllers have a requirement for adapter addresses to be assigned in a certain format or in a certain range of characters. The format you must use may contain fewer than 12 hexadecimal digits, or decimal digits only, or some other character pattern. A support program or the adapter microcode will convert short character patterns to 12 hexadecimal digits for use on the network.

Use of the NETBIOS interface usually requires the assignment of a NETBIOS name corresponding to each adapter address. Either the support program providing the NETBIOS interface support or the applications themselves maintain tables of the NETBIOS names and corresponding adapter addresses used in communication on the network.

The documentation packaged with devices, adapters, and programs explains the address formats and values used by and required for each adapter.

In addition to universally and locally administered (individual) addresses, IBM Token-Ring Network adapters also support the use of adapter group addresses and functional addresses.

Names and Addresses

One or more assigned names or addresses identify most application programs, support programs, and interfaces for communication and data exchange.

Most names can be recognizable words or combinations of letters and numbers. Some programs can use the device's network adapter address as an identifying name. Other programs require names of a specific format or convention, which is different from adapter addresses. Such names and addresses include network names, node names, and resource names used for host and controller communication and network management.

Support programs and interfaces often use a table or list to associate an adapter address with a sending or receiving application program name or address. Many of these programs or interfaces provide a function or file with which you assign the required names to create the lists or tables.

You must determine from the documentation packaged with each program or interface the required format for the names and addresses, and how to assign them.

Application programs that use gateway connections to communicate with remote hosts and with other types of networks particularly need careful consideration, so that the names and addresses assigned provide compatibility and uniqueness where required.

Network Management

IBM network application programs for the IBM Token-Ring Network include network management programs that provide a central point for obtaining:

- Network and adapter status for one or multiple LAN segments
- Logs, traces, and error indicators to use in network problem isolation and resolution
- Performance and utilization information to help in evaluating network traffic flow and distribution.

IBM Token-Ring Network adapters and interfaces are designed to obtain and provide certain status and error information.

Because each adapter periodically learns the adapter address of its nearest active upstream neighbor (NAUN), the adapter can detect that its NAUN has changed. The change in NAUN address may indicate that a device (that was formerly the NAUN) is no longer active or that it is having problems transmitting information on the ring.

The adapter detecting the address change can collect and transmit information on the ring indicating that it or its NAUN is not operating normally. Each adapter can also collect and provide information about soft and hard errors on its ring. The adapter addresses and error information can be used to determine the *fault domain* of a problem (or the portion of the ring most likely to contain a failing component).

Network Management Programs

The IBM Token-Ring Network can use the following IBM network management programs:

- IBM LAN Manager

  IBM LAN Manager Version 1.0 provides network management functions for single and multiple IBM Token-Ring Network LAN segments, including

  - Collecting and displaying network status
  - Logging network events (such as insertion and removal of stations, soft error reports, or alerts)
  - Reporting alerts to a NetView host
  - Communicating with bridges in the network to receive status and error information for the LAN segments connected by the bridges.

  IBM LAN Manager Version 2.0 provides network management functions for single and multiple IBM Token-Ring Network LAN segments, including:

  - Collecting and displaying network status
  - Logging network events (such as insertion and removal of stations, bridge performance notifications, soft error reports, or alerts)
  - Reporting alerts to a NetView host (using either NetView/PC or the IBM OS/2 Communications Manager)

- Responding to NetView operator commands that request additional network status or removal of a malfunctioning adapter from the network
- Communicating with bridges in the network to receive status and error information for the LAN segments connected by the bridges
- Changing bridge configuration parameters from the IBM LAN Manager station or from the NetView console through the IBM LAN Manager
- Monitoring adapter addresses and generating an alert if an address fails to respond.

• IBM LAN Network Manager

The IBM LAN Network Manager Version 1.0 is an enhancement to the IBM LAN Manager Version 2.0. It provides network management functions for single and multiple IBM Token-Ring Network LAN segments, including:

- Collecting and displaying network status
- Logging network events (such as insertion and removal of stations, bridge performance notifications, soft error reports, or alerts)
- Reporting alerts to a NetView host (using either NetView/PC or the IBM OS/2 Communications Manager)
- Responding to NetView operator commands that request additional network status or removal of a malfunctioning adapter from the network
- Communicating with bridges in the network to receive status and error information for the LAN segments connected by the bridges
- Changing bridge configuration parameters from the IBM LAN Network Manager station or from the NetView console through the IBM LAN Network Manager
- Automatically re-linking to specified bridges if the communication link is lost
- Communicating with IBM 8230 Token-Ring Network Controlled Access Units to aid in problem determination on the network
- Comparing adapter insertion on the network with the Configuration Table to ensure that all adapters present are authorized to be on the network
- Monitoring adapter addresses and generating an alert if an address fails to respond.

• IBM PC 3270 Emulation LAN Management Program

The IBM PC 3270 Emulation LAN Management Program reports network error conditions in the form of alerts to a NetView host. It reports alerts only for the LAN segment to which it is connected.

• IBM LAN Manager Entry

The IBM LAN Manager Entry program:

- Provides network management functions only for the LAN segment to which it is connected
- Reports network error conditions in the form of alerts to a NetView host
- Responds to SPCS commands from the NetView operator requesting network and adapter status or the removal of a malfunctioning adapter from the network.

IBM bridging products can pass adapter and network status to network management programs for the LAN segments connected by a bridge. Chapter 15 describes IBM bridging products. Chapter 14 describes IBM LAN management programs.

Performance, Utilization, and Trace

IBM bridging products provide performance information to help you evaluate the flow of traffic through a bridge:

- Indications of when a excessive number of frames could not be forwarded through a bridge and of the possible cause for the problem
- Counts of frames and bytes that were and were not forwarded through a bridge
- Notification to requesting network manager programs of performance counts and statistics.

The IBM Token-Ring Network Trace and Performance Program helps you trace and analyze ring traffic and utilization (on a single 4-Mbps ring) by:

- Tracing and counting frames and bytes sent over a LAN segment
- Presenting LAN segment utilization in graphs, panels, or tables.

The IBM Token-Ring Network 16/4 Trace and Performance Program enables you to monitor and analyze trace data, monitor and analyze a real time view of ring utilization, and collect ring station traffic statistics on either a 4- or 16-Mbps Token-Ring Network by:

- Tracing and counting frames and bytes sent over a LAN segment
- Presenting ring performance and utilization in panels, graphs, and tables
- Collecting and presenting traffic information about non-MAC frames sent between pairs of stations on the ring.

LAN administrators, engineers responsible for LAN subsystems, LAN consultants, and system and application programmers can use the Trace and Performance Programs to:

- Analyze application programs that use different protocols on the ring
- Find errors application programs by analyzing data
- Identify data errors when production networks are experiencing problems
- Solve gateway, server, and printer problems
- Obtain data throughput measurements
- Determine ring utilization by all or by a subset of stations
- Compile statistics on traffic handled by different ring stations.

Chapter 13 discusses bridge performance analysis and the Trace and Performance Programs.

Problem Determination and Resolution

Recognizing, isolating, and resolving problems on an IBM Token-Ring Network involves:

- Determining that there is a problem
- Determining the nature of the problem
- Using the required tools and procedures to resolve the problem.

To resolve a network hardware component failure, the procedures contained in the *IBM Token-Ring Network Problem Determination Guide*:

- Require information about the operating and error status of a ring and its components
- Use the ring and error status information and the network planning charts to isolate the problem to a portion of the ring
- Remove that portion from the ring, allowing the rest of the ring to continue to operate
- Isolate the problem to a component in the removed ring portion
- Indicate how to repair or replace the component
- Insert the repaired portion back into the ring.

The procedures are designed mainly for use in networks that contain at least one IBM workstation and use the Ring Diagnostic or a network management program to provide ring status and error information. There are, however, procedures included for networks that contain no IBM workstations and/or that have no program to provide ring and error status.

You and other persons responsible for network problem determination should review the *IBM Token-Ring Network Problem Determination Guide* before having to resolve a problem.

Note: Once a problem has been isolated to a segment of the network that uses telephone twisted-pair media, slightly different problem determination procedures may be required to complete resolution. See the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide* for more information.

The IBM Token-Ring Network problem determination procedures are performed most easily and efficiently when certain materials and information are available to use with them. The following sections describe those materials and information.

Determining Whether There Is a Problem

Indications of problems on an IBM Token-Ring Network can come from four main sources:

- A network user report that a device or application is no longer working, is not working normally, or is indicating an error condition.

  Providing training and assistance in the use of devices and programs on the network can minimize user errors. Establishing user problem reporting procedures helps resolve problems quickly and preserves the indicators and other information needed for problem resolution.

- A status or error indicator from a LAN manager program or other network application program (such as a bridging product).

  Status and error indicators that can be obtained at an IBM LAN Manager or IBM LAN Network Manager station include:

  - Network status (such as normal operation or beaconing)
  - Adapters currently active on the network, and information about when adapters become active and cease to be active on the network
  - Messages and alerts indicating soft errors, hard errors, and network component malfunctions
  - Notifications and log entries from bridges indicating bridge traffic flow statistics and status for the LAN segments connected to the bridges.

- A status or error indicator from a host network management tool and call to you from the host operator.

  IBM network manager programs can send alerts to NetView, containing information about:

  - The type of LAN problem or condition reported by the alert
  - The portion of the network involved (such as adapter addresses, or network names of stations or applications)
  - Recommended action to resolve the problem or condition. The recommended action often includes or consists of an instruction to call the administrator of the local area network, so that the required problem resolution can be done at the problem location.

- Analysis of performance and utilization information.

  Bridge performance information and ring utilization information from the IBM Trace and Performance Programs can help you evaluate traffic flow and distribution on the network.

Determining the Nature of the Problem

Reported symptoms and status and error information will help you determine the type or nature of the problem.

The nature of the problem usually indicates the tools and procedures that you must use to isolate and resolve the problem.

You will need to determine:

- Whether the problem is a hard or soft error, a hardware or software error, or a user error.
- What portion and component of the network is having the problem: a user, a program, a device, a network adapter, or another network component.

  Using application program or device error indications and problem determination procedures should resolve application program functional problems (such as program checks and incorrect configuration parameter values). It may also resolve some device and adapter failures and some data transmission problems.

  If not, the problem may be a network hardware failure (some data transmission problems can be caused by hardware failures) requiring use of procedures described in the *IBM Token-Ring Network Problem Determination Guide.* These procedures help you isolate and repair or replace a failing hardware component.

  The alerts sent to a host from an IBM Token-Ring Network program provide an indication of the nature and location of the problem. But further investigation is usually required at the problem location to completely isolate and resolve it.

  You will need to put procedures in place in your establishment for locating problems, removing portions of the network while problems are resolved, and returning portions of the network to operation.

Using the Required Tools and Procedures to Resolve the Problem

Procedures, publications, diagnostic tools, programs and network documentation all play a part in resolving network problems:

- Users may require instructions or other assistance in use of programs and devices on the network.
- User's guides, operator's guides, and reference manuals packaged with programs, devices, and network components describe actions and procedures to use to correct malfunctions.
- Diagnostic tests help you isolate a problem to the failing hardware or software.

  IBM Token-Ring Network problem determination procedures and diagnostic tests are used primarily to isolate and correct problems in adapters and network components.
- Network layout charts, building floor plans, and address-to-physical location charts help you locate failing components. The *IBM Token-Ring Network Introduction and Planning Guide* contains network planning charts and instructions for their use.
- In using network manager programs in an IBM Token-Ring Network, consider the location of the program in the network and how much information the program will provide.

  The IBM LAN Manager Versions 1.0 and 2.0, the IBM LAN Network Manager Version 1.0, the IBM LAN Manager Entry program, and the IBM PC 3270 Emulation LAN Management Program all report alerts to a NetView host.

The IBM LAN Manager (Versions 1.0 and 2.0) and the IBM LAN Network Manager Version 1.0 provide:

- Network and adapter information for a single IBM Token-Ring Network segment (the LAN segment to which the IBM LAN Manager or IBM LAN Network Manager is connected).

  The IBM LAN Manager Entry and the IBM PC 3270 Emulation LAN Management Program do not provide any network or adapter information at their workstations; they only report alerts to a NetView host for the single LAN segment to which they are connected.
- Network and adapter information for multiple LAN segments connected by bridges.

  The bridge products can report status and error information for the LAN segments they connect, and report bridge performance information helpful in evaluating traffic flow through a bridge.

Chapter 10 contains more information about user training and assistance. Chapter 11 discusses local area network problem reporting and resolution in more detail.

Interconnection

There are IBM products for use on the IBM Token-Ring Network that support:

- Bridging of LAN segments
- Gateways to hosts and other types of networks
- Remote connections to devices not directly connected to the network.

Bridging
IBM bridging products that can be used on the IBM Token-Ring Network include:

- The IBM Token-Ring Network Bridge Program (Versions 1.1, 2.0, 2.1, and 2.2)

  The IBM Token-Ring Network Bridge Program connects two IBM Token-Ring Network segments. The Bridge Program can communicate with the IBM LAN Manager (Versions 1.0 and 2.0) and the IBM LAN Network Manager either on one of the LAN segments connected to the bridge or through other bridges. Bridge Program Versions 2.1 and 2.2 provide remote bridge function, which connects two LAN segments through a telecommunications link between two halves of the bridge.

- The IBM PC Network Bridge Program

  The IBM PC Network Bridge Program connects either two IBM PC Network segments, one IBM PC Network segment and one IBM Token-Ring Network segment, or two IBM Token-Ring Network segments. The Bridge Program can communicate with the IBM LAN Manager (Version 1.0 if the IBM LAN Manager is on one of the LAN segments connected to the bridge; Version 2.0 either on one of the LAN segments connected to the bridge or through other bridges) and with the IBM LAN Network Manager (either on one of the LAN segments connected to the bridge or through other bridges).

- The IBM 8209 Local Area Network Bridge

  The IBM 8209 LAN Bridge connects either two IBM Token-Ring Network segments or an IBM Token-Ring segment and another kind of LAN segment, such as an Ethernet or IEEE 802.3 LAN segment. The IBM 8209 can communicate with the IBM LAN Manager or the IBM LAN Network Manager either on one of the LAN segments connected to the bridge or through other bridges.

- The IBM Token-Ring Network/PC Network Interconnect Program

  The Interconnect Program connects two IBM PC Network segments or one IBM PC Network segment and one IBM Token-Ring Network segment. Application programs use the NETBIOS interface to communicate through the Interconnect Program. The Interconnect Program maintains a table of NETBIOS symbolic names for the adapters sending and receiving information through the Interconnect Program.

Chapter 15 describes IBM bridging products for LANs.

Gateways
Workstations and controllers with appropriate software and adapters can provide gateway connections to a variety of networks and hosts. The gateway functions are usually included in programs that provide 3270 emulation, APPC support, and asynchronous communication, such as:

- IBM PC 3270 Emulation Program
- IBM Local Area Network Asynchronous Connection Server Program (LANACS)
- IBM Asynchronous Communications Server Program
- IBM 3172 Interconnect Controller Program
- IBM LAN to LAN Wide Area Network Program (LTLW).

Chapter 16 describes IBM LAN products that provide gateway connections.

Remote Connections
Three IBM products provide asynchronous communication server functions to allow LAN communication application programs to communicate with devices not directly connected to the network:

- LANACS
- IBM Asynchronous Communications Server Program
- IBM Remote NETBIOS Access Facility Program.

The remote device may actually be close enough to connect directly to the LAN, but cannot support the network protocols. If the device can be too far away for a direct connection, the connection is made through a PABX, CBX, or public switched network.

Chapter 16 describes the programs that provide asynchronous communication server functions.

Network Software

The software used in devices that connect to an IBM Token-Ring Network includes:

- Application programs
- Operating systems and subsystems
- Support programs and interfaces.

Application Programs

Application programs that communicate over an IBM Token-Ring Network vary with the work to be accomplished.

Application programs that provide services on the network include:

- Network management
  - IBM LAN Network Manager
  - IBM LAN Manager Version 1.0 (for multiple rings through bridges or for a single bus)
  - IBM LAN Manager Version 2.0 (for a single LAN segment or for multiple LAN segments through bridges and for responding to SPCS commands from NetView)
  - IBM LAN Network Manager Version 1.0 (for a single LAN segment or for multiple LAN segments through bridges and for responding to the LAN Network Manager Command List commands from NetView).
  - IBM 3270 PC Emulation LAN Management Program (for sending alerts to a NetView host from a single LAN segment)
  - IBM Personal Communications/3270 Emulation Program
  - IBM LAN Manager Entry (for sending alerts to a NetView host from a single LAN segment, and for responding to SPCS commands from NetView)
  - IBM Token-Ring Network Manager Version 1.1 (for a single ring only)[1]
- Interconnecting LAN segments
  - IBM Token-Ring Network Bridge Program (Versions 1.1, 2.0, 2.1, and 2.2)[2]
  - IBM PC Network Bridge Program
  - IBM Token-Ring Network/PC Network Interconnect Program
  - IBM LAN to LAN Wide Area Network Program
- Messaging, server, and resource sharing functions
  - IBM PC LAN Program
  - IBM Personal Services/PC
  - IBM OS/2 LAN Server Program
  - IBM TCP/IP Program
  - IBM APPC and APPC/PC Programs

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1 The IBM Token-Ring Network Manager program is no longer available from IBM.

2 The IBM Token-Ring Network Bridge Program, Versions 1.1, 2.0, and 2.1 are no longer available from IBM.

- Network status and error information reporting
  - IBM LAN Network Manager
  - IBM LAN Manager Version 1.0 (for multiple rings through bridges or for a single bus)
  - IBM LAN Manager Version 2.0 (for multiple LAN segments through bridges)
  - IBM LAN Network Manager Version 1.0 (for multiple LAN segments through bridges)
  - IBM Token-Ring Network Bridge Program (Versions 1.1, 2.0, 2.1, and 2.2)
  - IBM Token-Ring Network Ring Diagnostic
  - IBM PC Network Bridge Program
  - IBM Token-Ring Network Trace and Performance Programs
- Asynchronous communication servers
  - IBM Asynchronous Communications Server Program
  - LANACS Version 2.0
  - IBM Remote NETBIOS Access Facility Program.

Chapter 14, Chapter 15, and Chapter 16 describe application programs that provide network services.

Operating Systems and Subsystems

IBM PC DOS, IBM OS/2 EE, and AIX are the operating systems that run in workstations that connect to the IBM Token-Ring Network.

Products that use the network may require the features and support provided by a particular operating system at a particular level or version. The descriptions on the product packages and the publications included in the packages indicate the operating system requirements for the product, including:

- Which operating system
- Level or version
- System, data, configuration, and batch file formats and contents
- Program load commands and parameters.

Chapter 17 describes operating systems and subsystems that run in devices connected directly to the IBM Token-Ring Network and in hosts and controllers that access the network through workstations.

Support Programs and Interfaces

A number of IBM products provide adapter, protocol, and interface support for devices and applications that use the IBM Token-Ring Network.

Adapter Support

Workstations

The IBM LAN Support Program provides adapter support for the IBM Token-Ring Network adapters used in IBM Personal Computers, Industrial Computers, and Personal System/2 computers.

- IBM bridge programs, the IBM LAN Manager, and the IBM LAN Network Manager provide their own adapter support, similar to that provided by the IBM LAN Support Program. (The IBM 8209 Utility Program requires either the IBM LAN Support Program or the support included when a LAN Manager program shares the computer with the Utility Program.)
- The IBM RT PC has its own support code for its IBM Token-Ring Adapters.
- The IBM Token-Ring Network adapters first marketed by IBM used the Adapter Support Interface (TOKREUI.COM) supplied on the diskette packaged with each adapter. The IBM LAN Support Program replaces the function of TOKREUI.COM, which is no longer available from IBM.

Chapter 12 describes programs that provide network device and adapter support.

Hosts and Controllers

Host computers and controllers that communicate over token-ring networks fall into two categories.

1. Those that connect directly to the network
2. Those that access the network through an intermediary workstation.

For direct connection to the IBM Token-Ring Network, hosts require either operating system or program support, or both, for network attachment features and interfaces. Controllers also require attachment feature support and interface support, through microcode, control programs, and/or host operating system support.

Host computers and controllers that access the IBM Token-Ring Network through workstations connected both to the network and to the host or controller usually require host operating system, control program, or subsystem support. Particular configurations, features, or program packages may be needed to support communication between host and network devices and application programs (for example, 3270 emulation or APPC). The publications associated with the hosts and controllers and with the applications that communicate over the network describe the requirements for such communication.

Higher Level Protocols and Interfaces

A number of IBM products provide higher level protocols and interfaces for the IBM Token-Ring Network.

NETBIOS

The IBM Local Area Network Support Program provides NETBIOS interface support for IBM Token-Ring Network adapters, replacing the support previously provided by the IBM Token-Ring Network NETBIOS Program.[3]

The Remote NETBIOS Access facility Program provides NETBIOS-equivalent connections between network workstations and workstations that are not directly connected to an IBM Token-Ring Network.

The IBM PC LAN Program and the OS/2 LAN Server Program use the NETBIOS interface to provide network message, print server, and file server functions.

[3] The IBM Token-Ring Network NETBIOS Program is no longer available from IBM.

Some asynchronous communications between network workstations and remote workstations also use NETBIOS or NETBIOS-equivalent interfaces.

The IBM PC 3270 Emulation Program uses the NETBIOS interface; the IBM Personal Communications/3270 Emulation Program uses the NETBIOS interface when operating as a workstation and communicating with an IBM PC 3270 Emulation Program Gateway.

Device Emulation
Products that provide 3270 device emulation for workstations, gateway functions for controller and host connections, or both, include:

- The IBM PC 3270 Emulation Program
- The IBM 3270 Workstation Program
- The IBM Personal Communication/3270 Emulation Program
- LANACS.

APPC
Advanced Program-to-Program Communication for the Personal Computer (APPC/PC) allows workstations running transaction programs on a LAN to communicate with each other and with versions of APPC running in IBM System/370 or System/390, System/36 or 38, and 9370 hosts.

TCP/IP
The IBM 3172 Interconnect Controller supports connectivity between an IBM Token-Ring Network and a System/370 Version 1 or TCP/IP for MVS Version 1.0 or VM Version 1.2. Any device on the LANs using the TCP/IP protocol can communicate with System/370 through the 3172.

The IBM 8232 LAN Channel Station provides a direct channel connection between the IBM Token-Ring Network workstations and a host using TCP/IP with VM. AIX provides TCP/IP support for the IBM RT PC and RISC System/6000.

LANACS provides connection between:

- IBM Token-Ring Network workstations and a host using TCP/IP Telnet
- IBM Token-Ring Network workstations using TCP/IP Telnet and a host.

Asynchronous Communication
Products that provide asynchronous communication between LAN communication applications and remote non-SNA applications and devices, include:

- LANACS
- The IBM Asynchronous Communication Server Program
- The Remote NETBIOS Access Facility Program.

SNA Office Support
IBM Personal Services/PC provides office-oriented automated mail and file management functions for workstations. The IBM Series/1 Office Connect Program allows the Series/1 to act as an office server, facilitating communication between workstations using Personal Services/PC and office applications in a S/370 host.

Part 3 of this manual describes products that provide higher level protocol and interface support for the IBM Token-Ring Network.

Chapter 3. IBM PC Network Broadband

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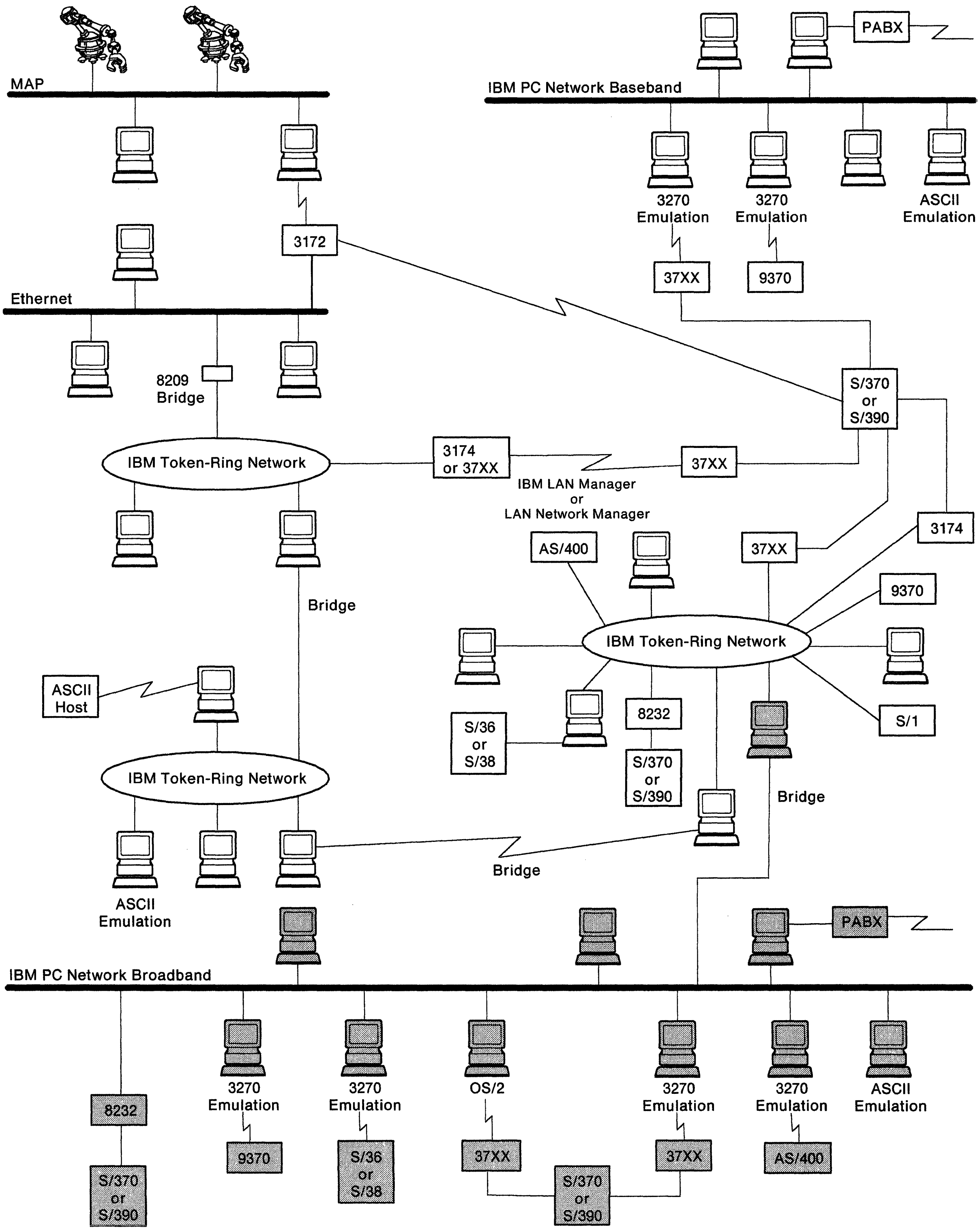

Figure 3-1. The IBM PC Network Broadband Portion of a Composite Local Area Network

Overview of the IBM PC Network Broadband

The IBM PC Network Broadband uses the tree topology. Figure 3-1 highlights the IBM PC Network Broadband portion of a composite LAN.

Each broadband network uses a pair of frequencies to transmit and receive programs, data, and messages between personal computers. The broadband network contains a translator unit that changes signals from one frequency to another, but leaves the information carried by that signal intact. Adapters in the personal computers attached to the network send and receive signal levels and frequencies compatible with the network requirements. These signals are carried by coaxial cables that, along with other passive network devices, provide the proper signal strength for the network components. The IBM PC Network Broadband uses the carrier sense multiple access with collision detection (CSMA/CD) method of contention.

Broadband networks can also handle other applications, such as video conferences and closed circuit TV (CCTV).

Broadband data networks connect a cluster of computers within a building or between buildings if the cable length limitations are not exceeded. You can connect a broadband network in many ways, so the physical layout of cables and the location of components vary between facilities.

You can build a small network of up to 72 devices; you should consult a professional network designer to plan and install a network containing more than 72 devices.

Hardware Components

Cable connects attaching devices to network connection points and to one another.

Cable for the broadband network is standard RG-11U coaxial cable provided in several precut lengths. You can join cables to form various lengths by replacing the 75-ohm terminator on one end of the cable with a cable adapter and connecting the other cable to the cable adapter. The *IBM PC Network Broadband Planning Guide* describes some rules to follow when joining cables.

Three cable kits contain splitters and attenuators that connect to any of the eight taps on a base expander. The attenuators allow for appropriate signal levels at various distances from the base expander. Network adapter cables connect to the splitter taps.

Translator units contain a frequency translator and a transformer. The frequency translator receives information at one frequency from adapters on the network and sends the information back to the adapters at another frequency. The transformer supplies power for the translator unit.

Each IBM PC Network segment must have either an IBM PC Network Translator Unit or a vendor-supplied translator unit. The IBM PC Network adapters that use frequency pairs designated as Frequency 2 and Frequency 3 cannot be used with IBM PC Network Translator Unit.

IBM PC Network Base Expanders attach to the connection hardware to allow connection of more than eight nodes to the translator unit or to locate nodes more than 61 m (200 ft) from the translator unit.

The base expander consists of an eight-way splitter and a connector to the directional coupler tap on the connection hardware. The taps on the eight-way splitter provide signal levels compatible with the short, medium, and long distance cable kits. However, the signal levels at the eight taps on the splitter are not attenuated enough to allow a network adapter cable to be directly attached. A 30 dB attenuator is provided to allow an adapter cable to be connected directly to the base expander for diagnostic purposes. The *IBM PC Network Broadband Planning Guide* and the cable kit installation instructions describe the requirements and procedures for attaching cables to the base expander with the proper signal attenuation.

IBM PC Network connection hardware attaches to the translator unit. The connection hardware has an eight-way splitter that allows connection of up to eight nodes. A directional coupler tap provides a tap for attachment to a base expander, which allows connection of up to 64 more nodes.

The taps on the connection hardware's eight-way splitter provide signal levels compatible with the network adapters in the personal computers. If a network adapter cable is not connected to a tap on the splitter, the tap must be capped with a terminator.

Attenuators provide attenuation that is constant over a wide range of frequencies and that is symmetrical from either end. Some standard attenuators are 3, 6, 10, and 20 dB. Other attenuators are physically variable and may be adjusted to meet your needs.

Network attenuation consists of two categories: *passive loss* and *cable loss*.

- *Passive loss* is attenuation caused by all of the passive components (components that do not require power to operate, such as couplers, splitters, and attenuators) in the network. Passive loss is constant across the entire frequency spectrum on the network. Constant-value losses enable you to predict power distribution and to design an efficient network.
- *Cable loss* is the attenuation caused by the coaxial cable. Cable loss increases with frequency.
  - *Cable tilt* is the difference in cable attenuation between the higher and lower frequencies, measured in dB.
  - *Tilt compensation* is the attenuation added to a network to provide equal attenuation at both the higher and lower frequencies, providing less signal distortion over the frequency range. Different types and lengths of coaxial cable require different tilt compensation.

Network balancing consists of adjusting the passive loss in the path to each node to obtain signals within the acceptance range at the device adapter and at the translator unit. You can adjust the loss in a path by changing attenuators or cable length.

Tilt compensators equalize cable tilt so that the attenuation at both high and low frequencies is the same. Tilt compensators have attenuation that varies with frequency in an inverse tilt relationship to the cable it is equalizing; that is, the higher the frequency, the lower the tilt compensator attenuation. Tilt compensators have symmetrical insertion loss, can be used in either direction, and have different tilt specifications over different frequency bandwidths.

Directional coupler taps are three-connector devices consisting of a line input, line output, and a tap-off port. The directional tap has an insertion loss and an attenuation value and provides isolation between the directional tap port and the line output port.

Splitters divide power. Typically, splitters provide two-way, four-way, or eight-way power splits. Isolation prevents any power from passing between split lines. Each split provides a tap for connecting an adapter cable or cable kit.

Terminators prevent reflections of power back into the cable system. A terminator is required at each unoccupied splitter tap.

IBM PC Network Broadband adapters are installed in each device on the network, and enable communication and data exchange on the network. See "Network Adapters and Attachment Features" for more information about IBM PC Network Broadband adapters.

Software support programs and interfaces assist adapters to become a part of the network and enable the exchange of data between application programs on the network. Support programs and interfaces provide functions such as:

- Protocol support and conversion
- Adapter or feature configuration
- Association between application program addressing and adapter or feature addressing
- Network access.

Network Adapters and Attachment Features

Each device that connects directly to an IBM PC Network Broadband must have a network adapter or attachment feature installed in it. Adapters plug into slots or positions in the attaching devices. Attaching devices and the adapters used in them include those listed in Table 3-1 on page 3-6.

Controllers and host computers that access the IBM PC Network Broadband through connections to workstations on the network, and not through direct connections to the network, include:

- IBM 3720, 3725, and 3745 Communications Controllers
- IBM System/36 or 38
- IBM AS/400
- IBM 9370 Information System
- Private Automated Branch Exchange (PABX).

Table 3-1. IBM PC Network Broadband Device and Adapter Combinations	
Type of Device	**Method of Attaching to Network**
IBM Personal Computers IBM Personal System/2 computers with PC I/O Channel architecture IBM Industrial Computers IBM 8232 LAN Channel Station	IBM PC Network Adapter [1] IBM PC Network Adapter II IBM PC Network Adapter II - Frequency 2 IBM PC Network Adapter II - Frequency 3
IBM Personal System/2 computers with Micro Channel architecture	IBM PC Network Adapter II/A IBM PC Network Adapter II/A - Frequency 2 IBM PC Network Adapter II/A - Frequency 3

The microcode on each adapter contains:

- An interface to communicate with the bus
- A protocol handler to process information going to and coming from the bus
- An interface through which the computer and the adapter share RAM and exchange processing control.

Adapter Configurable Hardware Options

Hardware switches, jumpers, and software configuration parameters allow you to define or set configuration options for each adapter in order to:

- Enable or disable adapter features and functions
- Assign values for adapter resource allocation
- Accommodate installation of multiple adapters in one device.

Workstation Adapters

Configurable hardware options set by switches, jumpers, or software allow you to define configuration parameters for each adapter, including:

- Whether the adapter is the primary or alternate network adapter when two network adapters are installed in one device
- Which interrupt level is to be used to exchange processing control between the adapter and the device
- What address the computer is to use to access the adapter's static random-access memory (SRAM) (and ROM for the Adapter II/As)
- Whether ROM is enabled or disabled on the adapter
- Whether Remote Program Load (RPL) is enabled or disabled on the adapter.

[1] This adapter is no longer available from IBM.

The IBM PC Network Broadband Adapter IIs have jumpers or switches that must be set before installing an adapter in a computer.

The *Installation Instructions* packaged with each adapter explain how to set the options for the adapter. The publications for application programs that use adapters should indicate any specific requirements for the settings.

The IBM PC Network Broadband Adapter II/As do not have jumpers or switches. A support program configuration process handles the adapter's features, functions, and assignments after the adapter is installed in the computer. The Reference Diskette for the computer in which the adapter is installed contains modules that provide the configuration support for the adapter.

The *Installation Instructions* packaged with each adapter explain how to install the adapter and verify its operation.

Adapter diagnostic tests, support programs, and some application programs display information indicating the result of setting the adapter configuration parameters (such as the current adapter interrupt level), allowing you to verify the settings.

Workstation adapter configurable hardware options include:

Primary/Alternate Adapter
If there are two network adapters (either two IBM PC Network adapters, or one IBM Token-Ring Network adapter and one IBM PC Network adapter) installed in a computer, one is designated as the primary adapter and the other as the alternate adapter. The primary adapter is also referred to as adapter 0; the alternate adapter is adapter 1.

Some products and programs have specific requirements for an adapter being primary or alternate. For example, if an IBM PC Network adapter and an IBM Token-Ring Network adapter are installed in the same device to be used by the same application program, the IBM PC Network adapter must be the primary adapter and the IBM Token-Ring adapter must be the alternate adapter.

The device type, the networks to which the device can attach, and the number of adapters in the device will determine the primary/alternate setting for each network adapter in your network.

The publications for the computer, the adapter, and the application program contain requirements for setting the primary/alternate adapter configuration parameter.

Interrupt Levels
There are several *interrupt levels* that the adapter, the computer, interfaces, support programs, and application programs use to transfer processing control from one to the other. The interrupt level to be used is set for each adapter.

IBM PC Network Broadband adapters and support code can use interrupt levels 2 and 3. Many application programs that use network adapters require that the adapter be set to a specific interrupt level. In choosing the interrupt level for each adapter in your network, you will need to consider the interrupt levels required and allowed for all the adapters installed in one device. For example:

- Printers frequently require level 7.
- Disk and diskette drives use level 6; this level should not be used for other adapters.
- Emulation products often require level 2. Level 2 cannot be used for an IBM PC Network Broadband adapter if it shares the computer with 3278/79 Emulation.

Remember that, generally, no two adapters installed in a single device can use the same interrupt level; and that each adapter must use an allowed or required level.

See the publications for programs, interfaces, and adapters for information on allowed and required interrupt levels.

Memory Segments
An adapter configuration parameter indicates the computer memory segment address to be recognized for the adapter's SRAM data buffers. For the Adapter II/As, the same memory segment is also used for adapter ROM.

Read-Only Memory (ROM)
The IBM PC Network Broadband adapters contain ROM in which reside power-on self-test (POST) diagnostic code and RPL code.

An adapter configuration parameter indicates to the computer whether the ROM for an adapter is enabled or disabled when there are two adapters installed in the same computer.

If there are two IBM PC Network adapters installed in the same computer, usually the ROM on only one of them should be enabled. For specific ROM setting requirements, refer to the *Installation Instructions* packaged with each adapter and to the publications packaged with programs that use the adapters on the network.

Remote Program Load (RPL)
The IBM PC Network Broadband adapter ROM contains code that allows programs and files to be loaded from one computer into the memory of another computer over the network, without requiring the receiving computer to use a fixed disk or diskette drive.

An adapter configuration parameter indicates whether the RPL code on an adapter is to be enabled or disabled.

Considerations
When two network adapters are installed in the same computer, the following considerations apply:

- An IBM PC Network Adapter cannot share the same interrupt level with **any** other adapter (including adapters for disk drives, graphics, emulation, and printers). Unless the adapters support interrupt sharing, adapters in the same computer cannot use the same interrupt level. One network adapter must use interrupt level 2; the other must use level 3.
- One network adapter must be selected as the primary adapter, and the other as the alternate adapter.
- No two adapters (network or other type) can use the same memory segment location.
- Only one network adapter can have RPL enabled.
- Usually, only one network adapter can have ROM enabled.
- When an IBM PC Network adapter and an IBM Token-Ring Network adapter are installed in the same computer, the IBM PC Network adapter must be the primary adapter.

Host and Controller Adapters and Attachment Features
Controllers and host computers access an IBM PC Network through workstations connected both to the network and to the host or controller. The connection to the host or controller can be a direct channel or a remote connection over a telecommunications link or public switched network. A controller connected to a workstation on the LAN may also connect directly or remotely to a host computer, thereby providing communication with the host for devices on the LAN.

Chapter 12 describes support programs used for host and controller access to an IBM PC Network Broadband.

Data Transmission

The IBM PC Network Broadband:

- Transmits data at 2 Mbps
- Uses the broadband transmission technique

  IBM PC Network broadband adapters can communicate on an IBM PC Network with other adapters using the same frequency pair. Multiple frequency channels can be carried by the same physical cable. However, communication between adapters using different frequency pairs (whether on the same or different physical cable) requires installation of a bridging product.

- Uses CSMA/CD contention to access the transmission media

  Any device on the network may transmit at any time providing no other device is using the channel. In the unlikely event that two devices start transmitting at the same time, both devices detect a collision of signals on the network and stop transmitting data. Each station sends a temporary jamming signal, waits a random length of time, and attempts the transmission again.

Transmission of Data on the Network

In order for an attaching device to communicate on the network, the device must contain:

- An operating system or subsystem
- A network adapter
- Cables to connect the adapter to the adjacent adapters or to connection hardware
- One or more application programs that can send and receive data on the network
- A support program or interface that handles communication between the adapter and the application programs. Although application programs can be written to communicate directly with the adapter, most require a support program. Part 3 of this manual describes support programs and interfaces used on the IBM PC Network Broadband.

Each time the power for a device containing an IBM PC Network adapter is turned on, a POST is executed from the adapter ROM to verify that:

- The adapter is operating correctly
- There is a cable connecting the adapter to the network
- The network carrier signal is in neither a continuous-carrier nor a no-carrier condition.

Before beginning to communicate on the network, the adapter checks to see whether another adapter is already transmitting. If so, the adapter waits a random length of time and checks again. Once the adapter determines that no other adapter is transmitting, it transmits a frame. The adapter then checks the network to see if another adapter transmitted at the same time. If a collision occurs, both adapters stop transmitting, wait a random length of time, and attempt transmission again.

Network Architecture

The IBM PC Network Broadband architecture is a proprietary implementation of CSMA/CD protocols.

Adapter support software provides access to the network through the two levels of communication with network adapters:

- The direct interface, which provides:
  - Basic adapter functions (the ability to open and close an adapter, obtain error status, and set addresses, for example)
  - Transmission of frames directly without LLC protocol assistance.
- The DLC interface, which provides:
  - Connectionless communication between devices providing no guarantee of delivery (through the DLC Service Access Point interface). These are primarily datagram and broadcast messages.
  - Connection-oriented services using LLC protocol (through the DLC station interface).

The use of the DLC and direct interfaces and the DLC, LLC, and MAC protocols by IBM PC Network application and support programs for workstation adapters is described in the *IBM Local Area Network Technical Reference*.

Protocols and Interfaces

The IBM PC Network Broadband uses CSMA/CD protocols to control data flow. IBM PC Network Broadband adapters implement the protocols involved in transmitting and receiving frames, and in recognizing the condition of the network.

Frame formats are described briefly in the *IBM Local Area Network Technical Reference*. The formats of the Routing information field, DLC header, and information field are described in more detail in the *IBM Token-Ring Network Architecture Reference* (these parts of the frame are identical in both the IBM Token-Ring Network and the IBM PC Network).

Higher Level Protocols and Interfaces

The IBM PC Network Broadband supports a number of the higher level protocols and interfaces described in "Higher Layer Protocols and Interfaces" on page 1-21:

NETBIOS
Applications on an IBM PC Network Broadband frequently use the NETBIOS interface, particularly for messaging, file server, and print server applications.

Device Emulation
The IBM PC Network Broadband uses device emulation primarily for access to hosts and controllers, which cannot connect directly to the network.

Workstations using 3270 emulation can communicate with:

- A System/370 or System/390 host through a connection to an IBM 3174 Establishment Controller or an IBM 3720, 3725, or 3745 Communications Controller
- An IBM 9370 host through a direct or remote host connection to the workstation, or through a controller connected to the host and to the workstation
- A System/36 or 38 host through a remote gateway connection to the host.

APPC
Advanced Program-to-Program Communication (APPC) provides a common Application Program Interface to transaction programs using the SNA LU 6.2 program-to-program interface.

Asynchronous Communication
Workstations on an IBM PC Network Broadband can function as asynchronous communication servers to connect LAN communication applications and remote non-SNA applications and devices.

SNA
Application programs on a broadband network can use 3270 emulation functions and APPC to communicate with SNA host computers.

TCP/IP
Transmission Control Protocol/Internet Protocol (TCP/IP) is a set of telecommunication standards introduced by the U.S. Department of Defense. Because TCP/IP has been implemented by IBM and many other companies, it provides a common interconnection to link a variety of different products. TCP/IP when used in an IBM VM environment, provides communication between hosts and workstations on several LANs, including the IBM PC Network Broadband, the IBM Token-Ring Network, and Ethernet.

Network Addressing

The IBM PC Network Broadband uses both major categories of LAN addressing described in "IBM LAN Network Addressing" on page 1-25:

Adapter addresses identify each unique adapter, groups of adapters, and functions provided by adapters on the network from one attaching device's adapter to another.

Names or addresses identify application programs, support programs, and interfaces to each other on the network.

Network Adapter Addresses

IBM PC Network Broadband adapters have a 12-digit hexadecimal universally administered address that is permanently encoded in the adapter's microcode when it is manufactured.

The IBM LAN Support Program and some network applications (including the IBM PC Network Bridge Program) allow you to override the universally administered address with a locally administered address that you assign.

Use of the NETBIOS interface usually requires the assignment of a NETBIOS name corresponding to each adapter address. Either the support program providing the NETBIOS interface support or the applications themselves maintain tables of the NETBIOS names and corresponding adapter addresses used in communication on the network.

In communication with hosts and controllers through gateway workstations, there may be a requirement for adapter addresses to be assigned in a certain format or in a certain range of characters. The format you must use may contain fewer than 12 hexadecimal digits, or decimal digits only, or some other character pattern. A support program or the adapter microcode will convert the character pattern to 12 hexadecimal digits for use on the network.

The documentation packaged with devices, adapters, and programs explains the address formats and values used by and required for each adapter.

In addition to universally and locally administered (individual) addresses, IBM broadband adapters with their associated adapter support code also support the use of adapter group addresses and functional addresses.

Names and Addresses

One or more assigned names or addresses identify most application programs, support programs, and interfaces for communication and data exchange.

Most names can be recognizable words or combinations of letters and numbers. Some programs can use the device's network adapter address as an identifying name. Other programs require names of a specific format or convention, which is different from adapter addresses.

Support programs and interfaces often use a table or list to associate an adapter address with a sending or receiving application program name or address. Many of these programs or interfaces provide a function or file with which you assign the required names to create the lists or tables.

You must determine from the documentation packaged with each program or interface the required format for the names and addresses, and how to assign them.

Applications that use gateway connections to communicate with remote hosts and with other types of networks need particularly careful consideration, so that the names and addresses assigned provide compatibility and uniqueness where required.

Network Management

IBM PC Network Broadband adapters with their associated adapter support code support network protocols and participate in network control and management by:

- Sending a status message once per minute, as long as they are active on the network
- Sensing the condition of the network carrier signal for continuous or no carrier conditions.

IBM network management programs provide a centralized means of obtaining information about the network, including:

- Network and adapter status for one or multiple LAN segments
- Logs, traces, and error indicators to use in network problem isolation and resolution
- Performance and utilization information to help in evaluating network traffic flow and distribution.

Network Management Programs

The IBM PC Network Broadband can use the following IBM network management programs:

- IBM LAN Manager

  IBM LAN Manager Version 1.0 provides network management functions for a single IBM PC Network Broadband LAN segment, including

  - Collecting and displaying LAN segment status
  - Logging network events (such as insertion and removal of stations, or alerts)
  - Reporting alerts to a NetView host.

  IBM LAN Manager Version 2.0 provides network management functions for single and multiple IBM PC Network Broadband LAN segments, including

  - Collecting and displaying network status
  - Logging network events (such as insertion and removal of stations, bridge performance notifications, or alerts)
  - Reporting alerts to a NetView host (using either NetView/PC or the IBM OS/2 Communications Manager)
  - Responding to NetView operator commands that request additional network status or removal of a malfunctioning adapter from the network
  - Communicating with bridge programs in the network to receive status and error information for the LAN segments connected by the bridges.

- IBM LAN Network Manager

  The IBM LAN Network Manager Version 1.0 is an enhancement to the IBM LAN Manager Version 2.0. It provides network management functions for single and multiple IBM PC Network Broadband LAN segments, including

  - Collecting and displaying network status
  - Logging network events (such as insertion and removal of stations, bridge performance notifications, soft error reports, or alerts)

- Reporting alerts to a NetView host (using either NetView/PC or the IBM OS/2 Communications Manager)
- Responding to NetView operator commands that request additional network status or removal of a malfunctioning adapter from the network
- Communicating with bridging products in the network to receive status and error information for the LAN segments connected by the bridges
- Changing bridge configuration parameters from the IBM LAN Network Manager station or from the NetView console through the IBM LAN Network Manager
- Automatically re-linking to specified bridges if the communication link is lost
- Comparing adapter insertion on the network with the Configuration Table to ensure that all adapters present are authorized to be on the network
- Monitoring adapter addresses and generating an alert if an address fails to respond.

- IBM PC 3270 Emulation LAN Management Program

  The IBM PC 3270 Emulation LAN Management Program reports network error conditions in the form of alerts to a NetView host. It reports alerts only for the LAN segment to which it is connected.

- IBM LAN Manager Entry

  The IBM LAN Manager Entry:

  - Provides network management functions only for the LAN segment to which it is connected
  - Reports network error conditions in the form of alerts to a NetView host.
  - Responds to SPCS commands from the NetView operator requesting network and adapter status or the removal of a malfunctioning adapter from the network.

Chapter 14 describes IBM LAN management programs.

Network Utilization

The Advanced Diagnostics packaged with the *IBM PC Network Hardware Maintenance and Service* manual provide a function to measure network utilization. The Network Utilization function displays the usage as a percentage of the traffic capacity of the network, changing the display as the usage changes. The display includes average, highest, lowest, and present usage percentages.

Problem Determination and Resolution

Recognizing, isolating, and resolving problems on an IBM PC Network Broadband involves:

- Determining that there is a problem

  Indications of problems on an IBM PC Network Broadband can come from four main sources:

  - A network user report that a device or application is no longer working, is not working normally, or is indicating an error condition

    Providing training and assistance in the use of devices and programs on the network can minimize user errors. Establishing user problem reporting procedures helps resolve problems quickly and preserves the indicators and other information needed for problem resolution.

  - A status or error indicator from a LAN manager program or other network application program (such as a bridging product)

    Status and error indicators that can be obtained at an IBM LAN Manager or IBM LAN Network Manager station include:

    - Network status (such as normal operation, continuous carrier, or no carrier)
    - Adapters currently active on the network, and information about when adapters become active and cease to be active on the network
    - Messages and alerts indicating non-isolating errors, hard errors, and network component malfunctions
    - Notifications and log entries from bridges indicating bridge traffic flow statistics and status for the LAN segments connected to the bridges.

  - A status or error indicator from a host network management tool and call to you from the host operator

    Alerts sent to NetView from the IBM LAN Manager, the IBM LAN Network Manager, the IBM PC 3270 Emulation LAN Management Program, or the IBM LAN Manager Entry Program contain information about:

    - The type of LAN problem or condition reported by the alert
    - The portion of the network involved (such as adapter addresses, or network names of stations or applications)
    - Recommended action to resolve the problem or condition. The recommended action often includes or consists of an instruction to call the administrator of the LAN, so that the required problem resolution can be done at the problem location.

  - Analysis of performance and utilization information

    Utilization percentages from the IBM PC Network Advanced Diagnostics and bridge program performance information can help you evaluate traffic flow and distribution on the network.

- Determining the nature of the problem

  Reported symptoms and status and error information will help you determine the type or nature of the problem.

  The nature of the problem usually indicates the tools and procedures that must be used to isolate and resolve the problem.

  You will need to determine:

  - Whether the problem is an isolating error (that stops communication on the network) or non-isolating error (impedes but does not stop communication on the network), a hardware or software error, or a user error
  - What portion and component of the network is having the problem; a user, a program, a device, a network adapter, or another network component

- Using the required tools and procedures to resolve the problem

  - Users may require instructions or other assistance in the use of programs and devices on the network.
  - User's guides, operator's guides, and reference manuals packaged with programs, devices, and network components describe actions and procedures to use to correct malfunctions.
  - Diagnostic tests help you isolate a problem to the failing hardware or software.

    The Advanced Diagnostics packaged with the *IBM PC Network Hardware Maintenance and Service* manual help you identify and repair or replace a failing network hardware component.

    POSTs, which run each time the workstation power is turned on or the computer is restarted, indicate an adapter malfunction and a continuous or no carrier condition.
  - Network layout charts, building floor plans, and address-to-physical location charts help you locate failing components. You can create them yourself, or have your professional network designer create them while your network is being installed.
  - You will need to put procedures in place in your establishment for locating problems, removing portions of the network while problems are resolved, and returning portions of the network to operation.
  - In using network manager programs in a broadband IBM PC Network, consider the location of the program in the network and how much information the program will provide.

    The IBM LAN Manager Versions 1.0 and 2.0, the IBM LAN Network Manager Version 1.0, the IBM LAN Manager Entry Program and the IBM PC 3270 Emulation LAN Management Program all report alerts to a NetView host.

    The IBM LAN Manager Entry and the IBM PC 3270 Emulation LAN Management Program do not provide any network or adapter information at their workstations; they only report alerts to a NetView host for the single LAN segment to which they are connected.

    The IBM LAN Manager Version 1.0 provides network and adapter information for the single IBM PC Network Broadband segment to which the IBM LAN Manager is connected.

The IBM LAN Manager Version 2.0 and the LAN Network Manager Version 1.0 provide network and adapter information for the single IBM PC Network Broadband segment to which the program is connected and for multiple LAN segments connected by bridges.

The IBM PC Network Bridge Program can report status and error information for the LAN segments they connect, and report bridge performance information helpful in evaluating traffic flow through a bridge.

Chapter 10 contains more information about user training and assistance. Chapter 11 discusses LAN problem reporting and resolution in more detail.

Interconnection

There are IBM products for use on the IBM PC Network Broadband that support:

- Bridging of LAN segments
- Gateways to hosts and other types of networks
- Remote connections to devices not directly connected to the network.

Bridging
IBM bridging products that can be used on the IBM PC Network Broadband include:

- The IBM PC Network Bridge Program

  The IBM PC Network Bridge Program connects either two IBM PC Network segments, one IBM PC Network segment and one IBM Token-Ring Network segment, or two IBM Token-Ring Network segments. The Bridge Program can communicate with the IBM LAN Manager:

  - Version 1.0 if the bridge and the IBM LAN Manager are connected to the same IBM PC Network segment
  - Version 2.0 if the bridge and the IBM LAN Manager are connected to the same LAN segment or connected through other bridges

    The Bridge Program can communicate with the IBM LAN Network Manager if the bridge and the IBM LAN Network Manager are connected to the same LAN segment or connected through other bridges.

- The IBM Token-Ring Network/PC Network Interconnect Program

  The Interconnect Program connects two IBM PC Network segments or one IBM PC Network segment and one IBM Token-Ring Network segment. Application programs use the NETBIOS interface to communicate through the Interconnect Program. The Interconnect Program maintains a table of NETBIOS symbolic names for the adapters sending and receiving information through the Interconnect Program.

Chapter 15 describes IBM bridging products for LANs.

Gateways
Though most devices that connect directly to an IBM PC Network Broadband are workstations, the workstations with appropriate software and adapters can provide gateway connections to a variety of controllers and hosts. The gateway functions are usually included in programs that provide other functions such as 3270 emulation, APPC support, and asynchronous communication, including:

- IBM PC 3270 Emulation Program
- IBM LAN Channel Support Program
- LANACS
- IBM 3172 Interconnect Controller Program
- IBM Asynchronous Communications Server Program
- IBM LAN to LAN Wide Area Network Program.

Chapter 16 describes IBM LAN products that provide gateway connections.

Remote Connections

Three IBM products provide asynchronous communication server functions to allow LAN communication applications to communicate with devices not directly connected to the network:

- LANACS
- IBM Asynchronous Communications Server Program
- IBM Remote NETBIOS Access Facility Program.

The remote device may actually be close enough to connect directly to the LAN, but cannot support the network protocols. If the device is too far away for a direct connection, the connection is made through a PABX, CBX, or public switched network.

Chapter 16 describes programs that provide asynchronous communication server functions.

Network Software

The software used in devices that connect to an IBM PC Network Broadband include:

- Application programs
- Operating systems and subsystems
- Support programs and interfaces.

Application Programs

Application programs that communicate over an IBM PC Network Broadband vary with the work to be accomplished.

Application programs that provide services on the network include:

- Network management
  - IBM LAN Manager Version 1.0 (on a single bus)
  - IBM LAN Manager Version 2.0 (for multiple LAN segments through bridges
  - IBM LAN Network Manager Version 1.0 (for multiple LAN segments through bridges)
  - IBM PC 3270 Emulation LAN Management Program (for sending alerts to a NetView host from a single LAN segment)
  - IBM LAN Manager Entry Program (for sending alerts to a NetView host from a single LAN segment, and for responding to SPCS commands from NetView)
- Interconnecting LAN segments
  - IBM PC Network Bridge Program
  - IBM Token-Ring Network/PC Network Interconnect Program
  - IBM LAN to LAN Wide Area Network Program
- Messaging, server, and resource sharing functions
  - IBM PC LAN Program
  - IBM OS/2 LAN Server Program
  - IBM TCP/IP Program
  - IBM APPC and APPC/PC Programs
  - IBM Personal Services/PC
- Network status and error information reporting
  - IBM LAN Manager Version 1.0 (on a single bus)
  - IBM LAN Manager Version 2.0 (for multiple LAN segments through bridges
  - IBM LAN Network Manager Version1.0 (for multiple LAN segments through bridges)
  - IBM PC Network Bridge Program
- Asynchronous communications servers
  - IBM Asynchronous Communications Server Program
  - LANACS
  - IBM Remote NETBIOS Access Facility Program.

Chapter 14, Chapter 15, and Chapter 16 describe application programs that provide network services.

Operating Systems and Subsystems

IBM PC DOS and IBM OS/2 EE are the operating systems that run in workstations that connect to the IBM PC Network Broadband.

The products that use the network may require the features and support provided by a particular operating system at a particular level or version. The descriptions on the product packages and the publications included in the packages indicate the operating system requirements for the product, including:

- Which operating system
- Level or version
- System, data, configuration, and batch file formats and contents
- Program load commands and parameters.

Host computers and controllers access the IBM PC Network through workstations connected both to the network and to the host or controller. Host operating systems and the control programs or subsystems that run in controllers may provide or require particular configurations, features, or program packages to support communication with devices and application programs on the IBM PC Network Broadband (such as 3270 emulation or APPC). The publications associated with the hosts and controllers and with the applications that communicate over the network describe the requirements for such communication.

Chapter 17 describes operating systems and subsystems that run in devices connected directly to the IBM PC Network Broadband and in hosts and controllers that access the network through workstations.

Support Programs and Interfaces

A number of IBM products provide adapter, protocol, and interface support for devices and applications that use the IBM PC Network Broadband.

Adapter Support

There are three sources of adapter support for IBM PC Network broadband adapters:

- Adapter microcode

  The IBM PC Network Adapter (the original IBM PC Network broadband adapter marketed by IBM) contains adapter support code in the adapter microcode. No additional program support is required for adapter operation.

- The IBM PC Network Protocol Driver program

  The IBM PC Network Broadband Adapter II, marketed by IBM after the original IBM PC Network Adapter, does not have adapter support code in the adapter microcode. The Adapter II requires program support for basic adapter functions and communication with application programs.

  The IBM PC Network Protocol Driver program provides adapter support for the IBM PC Network Adapter II. When the Protocol Driver runs in a computer in which an IBM PC Network Adapter II is installed, the Adapter II can communicate with any original IBM PC Network Adapter and with other Adapter IIs that also use the Protocol Driver.

- The IBM LAN Support Program

  The IBM LAN Support Program provides adapter support for all IBM PC Network broadband adapters. IBM PC Network broadband adapters that use the Support Program cannot communicate with adapters that use the IBM PC Network Protocol Driver, or with the original IBM PC Network Adapter that is not using the Support Program. (IBM bridge programs and the IBM LAN Manager 1.0 provide their own adapter support, similar to and compatible with that provided by the IBM LAN Support Program.)

Chapter 12 describes programs that provide network device and adapter support.

Higher Level Protocols and Interfaces

A number of IBM products provide higher level protocols and interfaces for the IBM PC Network Broadband.

NETBIOS

The IBM PC Network Protocol Driver program provides NETBIOS interface support for the IBM PC Network Broadband Adapter II. The Protocol Driver NETBIOS support is similar to and compatible with the NETBIOS interface support included in the IBM PC Network Adapter microcode.

The IBM Local Area Network Support Program provides NETBIOS interface support for all IBM PC Network adapters, including the IBM PC Network Adapter. (The IBM PC Network Adapter must use the Support Program to be able to communicate with an IBM PC Network Adapter II that uses the Support Program.)

The IBM PC LAN Program and the OS/2 LAN Server Program use the NETBIOS interface to provide network message, print server, and file server functions.

Some asynchronous communications between network workstations and remote workstations also use NETBIOS or NETBIOS-equivalent interfaces. For example, the Remote NETBIOS Access Facility Program provides NETBIOS-equivalent connections between network workstations and workstations that are not directly connected to an IBM PC Network.

The IBM PC 3270 Emulation Program uses the NETBIOS interface; the IBM Personal Communications/3270 Emulation Program uses the NETBIOS interface when operating as a workstation and communicating with an IBM PC 3270 Emulation Program Gateway.

Device Emulation

Products that provide 3270 device emulation for workstations, gateway functions for controller and host connections, or both, include:

- The IBM PC 3270 Emulation Program
- The IBM Personal Communications/3270 Emulation Program
- The IBM 3270 Workstation Program
- LANACS.

APPC

Advanced Program-to-Program Communications for the Personal Computer (APPC/PC) allows workstations running transaction programs on a local area network to communicate with each other and with versions of APPC running in IBM System/370 or System/390, System/36 or 38, and 9370 hosts.

TCP/IP

Versions of TCP/IP run with operating systems and VM in hosts and network workstations. LANACS provides connections between:

- IBM PC Network Broadband workstations and a host using TCP/IP Telnet
- IBM PC Network Broadband workstations using TCP/IP Telnet and a host.

Asynchronous Communication

Products that provide asynchronous communication between LAN communication applications and remote non-SNA applications and devices, include:

- LANACS
- The IBM Asynchronous Communication Server Program
- The Remote NETBIOS Access Facility Program.

SNA Office Support

IBM Personal Services/PC provides office-oriented automated mail and file management functions for workstations. The IBM Series/1 Office Connect Program allows the Series/1 to act as an office server, facilitating communication between workstations using Personal Services/PC and office applications in a S/370 host.

Part 3 of this manual describes products that provide high-level protocol and interface support for the IBM PC Network Broadband.

Chapter 4. IBM PC Network Baseband

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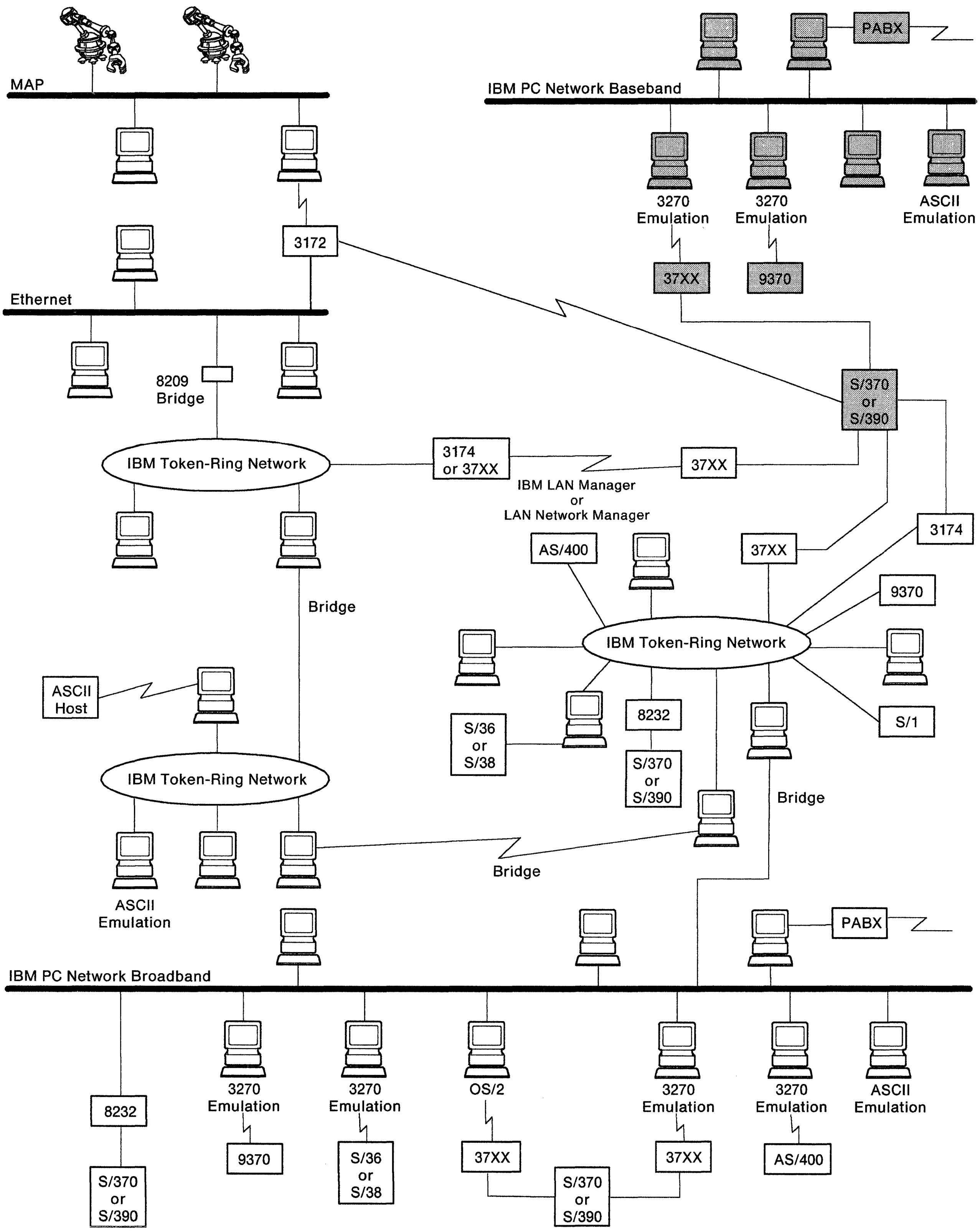

Figure 4-1. The IBM PC Network Baseband Portion of a Composite Local Area Network

Overview of the IBM PC Network Baseband

The IBM PC Network Baseband uses the bus topology for small LAN segments, which can be connected together in the tree topology to form larger LAN segments. Figure 4-1 highlights the IBM PC Network Baseband portion of a composite LAN. The IBM PC Network Baseband uses the carrier sense multiple access with collision detection (CSMA/CD) method of contention.

A baseband LAN segment can have as few as 2 and as many as 80 devices linked with IBM-specified twisted-pair media. You can create a small bus of up to eight devices by installing an IBM PC Network Baseband adapter in each device, cabling the adapters together, and installing the appropriate network software. You may create a larger tree (up to 80 devices) by connecting as many as 10 small buses with an IBM PC Network Baseband Extender. Large buses can also route data signals through wiring closets.

Hardware Components

Cable connects attaching devices to network connection points and to one another.

The cable used in an IBM PC Network Baseband can consist of any combination of existing telephone media, the IBM PC Network Baseband cables, or the appropriate IBM Cabling System media. You can use IBM Cabling System Types 1, 2, 3, 6, and 9 with a baseband IBM PC Network.

Although the baseband network transmits at 2 Mbps, it can operate successfully on a wide variety of telephone twisted-pair media in many general office environments at a low cost for each attached device. Telephone cabling in the network must meet the IBM Cabling System Type 3 media specifications.

Three types of IBM PC Network Baseband cables are available:

- The IBM Cabling System PC Network Baseband Cable connects the device adapter or Extender to the data-connector wall jack or data-connector distribution panel. The cable end that connects to the device adapter or Extender has a six-position, unkeyed, modular telephone plug; an IBM Cabling System data connector is at the other end.
- The IBM PC Network Baseband General Purpose Cable has a modular phone connector on one end and five spade-tipped leads on the other, to connect an adapter or an Extender to nonmodular telephone receptacles.
- The IBM PC Network Baseband Adapter Cable connects adapters serially or connects to the Extender; it has a modular phone connector on each end.

IBM PC Network Baseband Extender is a central connection unit for the baseband network. You can connect a small bus of up to 8 devices to each of the 10 IN ports for a total of 80 devices on a tree network.

Terminator and Wrap Plugs complete the electrical path in a baseband network.

The terminator plug is installed in either port of the adapter at one end of a serially-connected configuration. In a stand-alone configuration, the terminator plug is installed in the adapter in one end device and the wrap plug at the other. In a configuration attached to an Extender, a terminator plug is installed in the adapter in each device at the end of a series farthest from the Extender. A terminator plug is also installed in one of the OUT ports of the Extender.

The wrap plug is installed in the adapter in the device at one end of a serially-connected stand-alone configuration, and a terminator plug is installed at the other end. When an Extender is in the network, the wrap plug is installed in either of the OUT ports of the Extender.

Note: In any network, only one wrap plug is installed.

PC Network Baseband Adapters are installed in each device on the network, and enable communication and data exchange on the network. See "Network Adapters and Attachment Features" for more about IBM PC Network Baseband adapters.

Software support programs and interfaces assist application programs and adapters to become a part of the network and exchange data with other application programs on the network.

These programs provide functions such as:

- Protocol conversion
- Adapter or feature configuration
- Association between application program addressing and adapter or feature addressing
- Network access.

Network Adapters and Attachment Features

Each device that connects directly to an IBM PC Network Baseband must have a network adapter or attachment feature installed in it. Adapters plug into slots or positions in the attaching devices. Attaching devices and the adapters used in them include those listed in Table 4-1 on page 4-5.

Controllers and host computers that access the IBM PC Network Baseband through connections to workstations on the network, and not through direct connections to the network, include:

- IBM 3720, 3725, and 3745 Communications Controllers
- IBM 9370 Information System
- Private Automated Branch Exchange (PABX).

Table 4-1. IBM PC Network Baseband Device and Adapter Combinations	
Type of Device	**Method of Attaching to Network**
IBM Personal Computers IBM Personal System/2 computers with PC I/O Channel architecture IBM Industrial Computers	IBM PC Network Baseband Adapter
IBM Personal System/2 computers with Micro Channel architecture	IBM PC Network Baseband Adapter/A
IBM Industrial Computers	

The microcode on each adapter contains:

- An interface to communicate with the bus
- A protocol handler to process information going to and coming from the bus
- An interface through which the computer and the adapter share RAM and exchange processing control.

Adapter Configurable Hardware Options

Hardware switches, jumpers, and software configuration parameters allow you to define or set configuration options for each adapter, in order to:

- Enable or disable adapter features and functions
- Assign values for adapter resource allocation
- Accommodate installation of multiple adapters in one device.

Workstation Adapters

Configurable hardware options set by switches, jumpers, or software allow you to define configuration parameters for each adapter, including:

- Whether the adapter is the primary or alternate network adapter when two network adapters are installed in one device
- Which interrupt level is to be used to exchange processing control between the adapter and the device
- What address the computer is to use to access the adapter's static random access memory (SRAM) (and ROM for the Adapter/A)
- Whether ROM is enabled or disabled on the adapter
- Whether Remote Program Load (RPL) is enabled or disabled on the adapter.

The IBM PC Network Baseband Adapters have jumpers or switches that must be set before installing an adapter in a computer.

The *Installation Instructions* packaged with each adapter explain how to set the options for the adapter. The publications for application programs that use adapters should indicate any specific requirements for the settings.

The IBM PC Network Baseband Adapter/A does not have jumpers or switches. Its features, functions, and assignments are handled through a support program configuration process after the adapter is installed in the computer. The Reference Diskette for the computer in which the adapter is installed contains modules that provide the configuration support for the adapter.

The *Installation Instructions* packaged with each adapter explain how to install the adapter and verify its operation.

Adapter diagnostic tests, support programs, and some application programs display information indicating the result of setting the adapter configuration parameters (such as the current adapter interrupt level), allowing you to verify the settings.

Primary/Alternate Adapter
If there are two network adapters (either two IBM PC Network adapters, or one IBM Token-Ring Network adapter and one IBM PC Network adapter) installed in a computer, one is designated as the primary adapter and the other is the alternate adapter. The primary adapter is also referred to as adapter 0; the alternate adapter is adapter 1.

Some products and programs have specific requirements for an adapter being primary or alternate. For example, if an IBM PC Network adapter and an IBM Token-Ring Network adapter are installed in the same device to be used by the same application program, the IBM PC Network adapter must be the primary adapter and the IBM Token-Ring adapter must be the alternate adapter.

The device type, the networks to which the device can attach, and the number of adapters in the device will determine the primary/alternate setting for each network adapter in your network.

The publications for the computer, the adapter, and the application program contain requirements for setting the primary/alternate adapter configuration parameter.

Interrupt Levels
There are several *interrupt levels* that the adapter, the computer, interfaces, support programs, and application programs use to transfer processing control from one to the other. The interrupt level to be used is set for each adapter.

IBM PC Network Baseband adapters and support code can use interrupt levels 2 and 3. Many application programs that use network adapters require the adapter to be set to a specific interrupt level. In choosing the interrupt level for each adapter in your network, you will need to consider the interrupt levels required and allowed for all the adapters installed in one device. For example:

- Printers frequently require level 7.
- Disk and diskette drives use level 6; this level should not be used for other adapters.
- Emulation products often require level 2. Level 2 cannot be used for an IBM PC Network Baseband adapter if it shares the computer with 3278/79 Emulation.

Remember that, generally, no two adapters installed in a single device can use the same interrupt level; and that each adapter must use an allowed or required level.

See the publications for programs, interfaces, and adapters for information on allowed and required interrupt levels.

Memory Segments
An adapter configuration parameter indicates the computer memory segment address to be recognized for the adapter's static random-access memory (SRAM) data buffers. For the Adapter/As, the same memory segment is also used for adapter ROM.

Read-Only Memory (ROM)
The IBM PC Network Baseband adapters contain read-only memory (ROM) in which reside power-on self-test (POST) diagnostic code and RPL code.

An adapter configuration parameter indicates to the computer whether the ROM for an adapter is enabled or disabled when there are two adapters installed in the same computer.

If there are two IBM PC Network adapters installed in the same computer, usually the ROM on only one of them should be enabled. For specific ROM setting requirements, refer to the *Installation Instructions* packaged with each adapter and to the publications packaged with programs that use the adapters on the network.

Remote Program Load (RPL)
The IBM PC Network Baseband adapter ROM contains code that allows programs and files to be loaded from one computer into the memory of another computer over the network, without requiring the receiving computer to use a fixed disk or diskette drive.

An adapter configuration parameter indicates whether the RPL code on a adapter is to be enabled or disabled.

Considerations
When two network adapters are installed in the same computer, the following considerations apply:

- Unless the adapters support interrupt sharing, a network adapters cannot use the same interrupt level as **any** other adapter (including adapters for disk drives, graphics, emulation, and printers). One network adapter must use interrupt level 2; the other must use level 3.
- One network adapter must be selected as the primary adapter, and the other as the alternate adapter.
- No two adapters (network or other type) can use the same memory segment location.

- Only one network adapter can have RPL enabled.
- Usually, only one network adapter can have ROM enabled.
- When an IBM PC Network adapter and an IBM Token-Ring Network adapter are installed in the same computer, the IBM PC Network adapter must be the primary adapter.

Host and Controller Adapters and Attachment Features
Controllers and host computers access an IBM PC Network through workstations connected both to the network and to the host or controller. The connection to the host or controller can be a direct channel or a remote connection over a telecommunications link or public switched network. A controller connected to a workstation on the local area network may also connect directly or remotely to a host computer, thereby providing communication with the host for devices on the LAN.

Chapter 12 describes support programs used for host and controller access to an IBM PC Network Baseband.

Data Transmission

The IBM PC Network Baseband:

- Transmits data at 2 Mbps.
- Uses the baseband transmission technique.

  Each transmitted message uses the entire signal bandwidth on the cable. One user at a time can transmit; another user cannot begin transmission until the first user has relinquished use of the physical medium.
- Uses CSMA/CD contention to access the transmission media.

  Any device on the network may transmit at any time providing no other device is transmitting data. In the unlikely event that two devices start transmitting at the same time, both devices detect a collision of signals on the network and stop transmitting data. Each station sends a temporary jamming signal, waits a random length of time, and attempts the transmission again.

Transmission of Data on the Network

In order for an attaching device to communicate on the network, the device must contain:

- An operating system or subsystem
- A network adapter
- Cables to connect the adapter to the adjacent adapters or to connection hardware
- One or more application programs that can send and receive data on the network
- A support program or interface that handles communication between the adapter and the application programs. Though application programs can be written to communicate directly with the adapter, most require a support program. Part 3 of this manual describes support programs and interfaces used on the IBM PC Network Baseband.

Each time the power for a device containing an IBM PC Network adapter is turned on, a POST is executed from the adapter ROM to verify that:

- The adapter is operating correctly
- There is a cable connecting the adapter to the network
- A test message sent along the cable can pass through the cable and return unchanged.

Before beginning to communicate on the network, an adapter checks to see whether another adapter is already transmitting. If so, the adapter waits a random length of time and checks again. Once the adapter determines that no other adapter is transmitting, it transmits a frame. The adapter then checks the network to see if another adapter transmitted at the same time. If a collision occurs, both adapters stop transmitting, wait a random length of time, and attempt transmission again.

Network Architecture

The IBM PC Network Baseband architecture is a proprietary implementation of CSMA/CD protocols.

Adapter support software provides access to the network through the two levels of communication with network adapters:

- The direct interface, which provides
  - Basic adapter functions (the ability to open and close an adapter, obtain error status, and set addresses, for example)
  - Transmission of frames directly without LLC protocol assistance.
- The DLC interface, which provides
  - Connectionless communication between devices providing no guarantee of delivery (through the DLC Service Access Point interface). These are primarily datagram and broadcast messages.
  - Connection-oriented services using LLC protocol (through the DLC station interface).

The use of the DLC and direct interfaces and the DLC, LLC, and MAC protocols by IBM PC Network application and support programs for workstation adapters is described in the *IBM Local Area Network Technical Reference*.

Protocols and Interfaces

The IBM PC Network Baseband uses CSMA/CD protocols to control data flow. IBM PC Network Baseband adapters implement the protocols involved in transmitting and receiving frames, and in recognizing the condition of the network.

Frame formats are described briefly in the *IBM Local Area Network Technical Reference*. The formats of the Routing information field, DLC header, and information field are described in more detail in the *IBM Token-Ring Network Architecture Reference* (these parts of the frame are identical in both the IBM Token-Ring Network and the IBM PC Network).

Higher Level Protocols and Interfaces

The IBM PC Network Baseband supports products that use a number of the higher level protocols and interfaces described in "Higher Layer Protocols and Interfaces" on page 1-21.

NETBIOS

The NETBIOS interface is frequently used by applications on an IBM PC Network Baseband, particularly for messaging, file server, and print server applications.

Device Emulation
Device emulation is used on the IBM PC Network Baseband primarily for access to hosts and controllers that cannot connect directly to the network.

Workstations using 3270 emulation can communicate with:

- A System/370 or System/390 host through a connection to an IBM 3174 Establishment Controller an IBM 3720, 3725, or 3745 Communications Controller
- An IBM 9370 host through a direct or remote host connection to the workstation, or through a controller connected to the host and to the workstation
- A System/36 or 38 host through a remote gateway connection to the host.

APPC
Advanced Program-to-Program Communication (APPC) provides a common Application Program Interface to transaction programs using the SNA LU 6.2 program-to-program interface.

Asynchronous Communication
Workstations on an IBM PC Network Baseband can function as asynchronous communication servers to connect LAN communication application programs and remote non-SNA application programs and devices.

Network Addressing

The IBM PC Network Baseband uses both major categories of LAN addressing described in "IBM LAN Network Addressing" on page 1-25:

> **Adapter addresses** identify each unique adapter, groups of adapters, and functions provided by adapters on the network from one attaching device's adapter to another.
>
> **Names or addresses** identify application programs, support programs, and interfaces to each other on the network.

Network Adapter Addresses

IBM PC Network Baseband adapters have a 12-digit hexadecimal universally administered address that is permanently encoded in the adapter's microcode as it is manufactured.

The IBM LAN Support Program and some network applications allow you to override the universally administered address with a locally administered address that you assign.

Use of the NETBIOS interface usually requires the assignment of a NETBIOS name corresponding to each adapter address. Either the support program providing the NETBIOS interface support or the applications themselves maintain tables of the NETBIOS names and corresponding adapter addresses used in communication on the network.

In communication with hosts and controllers through gateway workstations, there may be a requirement for adapter addresses to be assigned in a certain format or in a certain range of characters. The format you must use may contain fewer than 12 hexadecimal digits, or decimal digits only, or some other character pattern. A support program or the adapter microcode will convert the character pattern to 12 hexadecimal digits for use on the network.

The documentation packaged with devices, adapters, and programs explains the address formats and values used by and required for each adapter.

In addition to universally and locally administered (individual) addresses, IBM baseband adapters with their associated adapter support code also support the use of adapter group addresses and functional addresses.

Names and Addresses

One or more assigned name or addresses identify most application programs, support programs, and interfaces for communication and data exchange.

Most names can be recognizable words or combinations of letters and numbers. Some programs can use the device's network adapter address as an identifying name. Other programs require names of a specific format or convention, which is different from adapter addresses.

Support programs and interfaces often use a table or list to associate an adapter address with a sending or receiving application program name or address. Many of these programs or interfaces provide a function or file with which you assign the required names to create the lists or tables.

You must determine from the documentation packaged with each program or interface the required format for the names and addresses, and how to assign them.

Application programs that use gateway connections to communicate with remote hosts and with other types of networks need particularly careful consideration, so that the names and addresses assigned provide compatibility and uniqueness where required.

Network Management

IBM PC Network Baseband adapters with their associated adapter support code support network protocols and participate in network control and management by:

- Sending a status message once per minute, as long as they are active on the network
- Sensing the condition of the network carrier signal for no carrier conditions.

IBM network management programs provide a centralized means of obtaining information about the network, including:

- LAN segment and adapter status
- Network utilization information to help in evaluating network traffic flow and distribution.

Network Management Programs

The IBM PC Network Baseband can use the following IBM network management programs for managing single segments and multiple segments.

Single segments of the IBM PC Network Baseband can use the following IBM network management programs (described in Chapter 14 of this manual):

- IBM PC 3270 Emulation LAN Management Program
  - Reports LAN segment error conditions in the form of alerts to a NetView host
- IBM LAN Manager Entry Program
  - Reports network error conditions in the form of alerts to a NetView host
  - Responds to SPCS commands from the NetView operator requesting network and adapter status or the removal of a malfunctioning adapter from the network.
- IBM LAN Network Manager Version 1.0
  - Collects and displays LAN segment status
  - Logs network events (such as insertion and removal of stations, or alerts)
  - Reports network error conditions in the form of alerts to a NetView host and to the LAN Network Manager console
  - Responds to NetView operator commands that request network and adapter status or the removal of a malfunctioning adapter from the network.

Note: Neither the IBM PC 3270 Emulation LAN Management Program nor the IBM LAN Manager Entry Program provide network status or error indications at their workstation.

The IBM LAN Manager Version 1.0 provides network management functions for single and multiple IBM PC Network Baseband LAN segments, including:

- Collecting and displaying network status
- Logging network events (such as insertion and removal of stations, bridge performance notifications, or alerts)

- Reporting alerts to a NetView host (using either NetView/PC or the IBM OS/2 Communications Manager)
- Responding to NetView operator commands that request additional network status or removal of a malfunctioning adapter from the network
- Communicating with bridge programs in the network to receive status and error information for the LAN segments connected by the bridges
- Providing asset management and access control functions to ensure that no unauthorized adapters remain on the network.

Network Utilization

The Advanced Diagnostics packaged with the *IBM PC Network Hardware Maintenance and Service* manual provide a function to measure network utilization. The Network Utilization function displays the usage as a percentage of the traffic capacity of the network, changing the display as the usage changes. The display includes average, highest, lowest, and present usage percentages.

Problem Determination and Resolution

Recognizing, isolating, and resolving problems on an IBM PC Network Baseband involves:

- Determining that there is a problem

  Indications of problems on an IBM PC Network Baseband can come from three main sources:

  - A network user report that a device or application is no longer working, is not working normally, or is indicating an error condition

    Providing training and assistance in the use of devices and programs on the network can minimize user errors. Establishing user problem reporting procedures helps resolve problems quickly and preserves the indicators and other information needed for problem resolution.

  - A status or error indicator from a host network management tool and call to you from the host operator

    The alerts sent to NetView from the IBM PC 3270 Emulation LAN Management Program, the IBM LAN Network Manager Program, and the IBM LAN Manager Entry Program contain information about:

    - The type of LAN problem or condition reported by the alert
    - The portion of the network involved (such as adapter addresses, or network names of stations or applications)
    - Recommended action to resolve the problem or condition. The recommended action often includes or consists of an instruction to call the administrator of the LAN, so that problem resolution can be done at the problem location.

    Status and error indicators that can be obtained using SPCS commands at a NetView host include:

    - LAN segment status (such as normal operation or no carrier)
    - Adapters currently active on the network
    - Messages and alerts indicating non-isolating errors, hard errors, and network component malfunctions
    - A status or error indicator from a LAN manager program or other network application program (such as a bridging product)

      Status and error indicators that can be obtained at an IBM LAN Network Manager station include:

      - Network status (such as normal operation, continuous carrier, or no carrier)
      - Adapters currently active on the network, and information about when adapters become active and cease to be active on the network
      - Messages and alerts indicating non-isolating errors, hard errors, and network component malfunctions
      - Notifications and log entries from bridges indicating bridge traffic flow statistics and status for the LAN segments connected to the bridges.

- Analysis of utilization information

  Utilization percentages from the IBM PC Network Advanced Diagnostics can help you evaluate traffic flow and distribution on the network.

- Determining the nature of the problem

  Reported symptoms and status and error information will help you determine the type or nature of the problem.

  The nature of the problem usually indicates the tools and procedures that must be used to isolate and resolve the problem.

  You will need to determine:

  - Whether the problem is a hard or soft error, a hardware or software error, or a user error
  - What portion and component of the network is having the problem: a user, a program, a device, a network adapter, or another network component.

- Using the required tools and procedures to resolve the problem

  - Users may require instructions or other assistance in use of programs and devices on the network.
  - User's guides, operator's guides, and reference manuals packaged with programs, devices, and network components describe actions and procedures to use to correct malfunctions.
  - Diagnostic tests help you isolate a problem to the failing hardware or software.

    The Advanced Diagnostics packaged with the *IBM PC Network Hardware Maintenance and Service* manual help you identify and repair or replace a failing network hardware component.

    POSTs, which run each time the workstation power is turned on or the computer is restarted, indicate an adapter malfunction and a continuous or no carrier condition.

  - Network layout charts, building floor plans, and address-to-physical location charts help you locate failing components. You can create them yourself, or have your professional network designer create them while your network is being installed.
  - You will need to put procedures in place in your establishment for locating problems, removing portions of the network while problems are resolved, and returning portions of the network back to operation.
  - In using network manager programs in a baseband IBM PC Network, consider the location of the program in the network and how much information the program will provide.

    The IBM LAN Network Manager, the IBM LAN Manager Entry Program, and the IBM PC 3270 Emulation LAN Management Program all report alerts to a NetView host.

    The IBM LAN Manager Entry and the IBM PC 3270 Emulation LAN Management Program do not provide any network or adapter information at their workstations; they only report alerts to a NetView host for the single LAN segment to which they are connected.

The IBM LAN Network Manager provides network and adapter information for the single IBM PC Network Baseband segment to which it is connected and for multiple LAN segments connected by bridges.

The IBM PC Network Bridge Program can report status and error information for the LAN segments they connect, and report bridge performance information helpful in evaluating traffic flow through a bridge.

Chapter 10 contains more information about user training and assistance. Chapter 11 discusses LAN problem reporting and resolution in more detail.

Interconnection

There are IBM products for use on the IBM PC Network Baseband that support:

- Bridging between LAN segments
- Gateways to hosts and other types of networks
- Remote connections to devices not directly connected to the network.

Bridging

The IBM PC Network Bridge Program connects either two IBM PC Network segments, one IBM PC Network segment and one IBM Token-Ring segment, or two IBM Token-Ring segments. The Bridge Program can communicate with the LAN Network Manager if the bridge and the IBM LAN Network Manager or LAN Manager are connected to the same LAN segment or connected through other bridges.

Gateways

Although most devices that connect directly to an IBM PC Network Baseband are workstations, the workstations with appropriate software and adapters can provide gateway connections to a variety of controllers and hosts. The gateway functions are usually included in programs that provide 3270 emulation, APPC support, and asynchronous communication:

- IBM PC 3270 Emulation Program
- LANACS
- IBM 3172 Interconnect Controller Program
- IBM Asynchronous Communications Server Program
- IBM LAN to LAN Wide Area Network Program.

Chapter 16 describes IBM LAN products that provide gateway connections.

Remote Connections
Three IBM products provide asynchronous communication server functions to allow LAN communication applications to communicate with devices not directly connected to the network:

- LANACS
- IBM Asynchronous Communications Server Program
- IBM Remote NETBIOS Access Facility Program.

The remote device may actually be close enough to connect directly to the LAN, but cannot support the network protocols. If the device is too far away for a direct connection, the connection is made through a PABX, CBX, or public switched network.

Chapter 16 describes the programs that provide asynchronous communication server functions.

Network Software

The software used in devices that connect to an IBM PC Network Baseband include:

- Application programs
- Operating systems and subsystems
- Support programs and interfaces.

Application Programs

Application programs that communicate over an IBM PC Network Baseband vary with the work to be accomplished.

Application programs that provide services on the network include:

- Network management
  - IBM 3270 PC Emulation LAN Management Program (for sending alerts to a NetView host from a single LAN segment)
  - IBM LAN Manager Entry (for sending alerts to a NetView host from a single LAN segment, and for responding to SPCS commands from NetView)
  - IBM LAN Network Manager (for multiple LAN segments through bridges)
- Interconnecting LAN segments
  - IBM PC Network Bridge Program
  - IBM LAN to LAN Wide Area Network Program
- Messaging, server, and resource sharing functions
  - IBM PC LAN Program
  - IBM OS/2 LAN Server Program
  - IBM Personal Services/PC
- Asynchronous communication servers
  - IBM Asynchronous Communications Server Program
  - IBM Remote NETBIOS Access Facility Program
  - LANACS (Version 2.0 only).

Chapter 14, Chapter 15, and Chapter 16 describe application programs that provide network services.

Operating Systems and Subsystems

IBM PC DOS and IBM OS/2 EE are the operating systems that run in workstations that connect to the IBM PC Network Baseband.

The products that use the network may require the features and support provided by a particular operating system at a particular level or version. The descriptions on the product packages and the publications included in the packages indicate the operating system requirements for the product, including:

- Which operating system
- Level or version
- System, data, configuration, and batch file formats and contents
- Program load commands and parameters.

Host computers and controllers access the IBM PC Network through workstations connected both to the network and to the host or controller. Host operating systems and the control programs or subsystems that run in controllers may provide or require particular configurations, features, or program packages to support communication with devices and application programs on the IBM PC Network Baseband (such as 3270 emulation or APPC). The publications associated with the hosts and controllers and with the application programs that communicate over the network describe the requirements for such communication.

Chapter 17 describes operating systems and subsystems that run in devices connected directly to the IBM PC Network Baseband and in hosts and controllers that access the network through workstations.

Support Programs and Interfaces

A number of IBM products provide adapter, protocol, and interface support for devices and application programs that use the IBM PC Network Baseband.

Adapter Support

The IBM LAN Support Program provides adapter support for IBM PC Network Baseband adapters. Chapter 12 describes this program.

Higher Level Protocols and Interfaces

A number of IBM products provide higher level protocols and interfaces for the IBM PC Network Baseband.

NETBIOS

The IBM LAN Support Program provides NETBIOS interface support to programs and adapters in network workstations.

The IBM PC LAN Program uses the NETBIOS interface to provide network message, print server, and file server functions.

The Remote NETBIOS Access facility Program provides NETBIOS-equivalent connections between network workstations and workstations that are not directly connected to an IBM PC Network.

Some asynchronous communications between network workstations and remote workstations also use NETBIOS or NETBIOS-equivalent interfaces.

Device Emulation

Products that provide 3270 device emulation for workstations, gateway functions for controller and host connections, or both, include:

- The IBM PC 3270 Emulation Program
- The IBM Personal Communications/3270 Emulation Program
- The IBM 3270 Workstation Program
- LANACS.

APPC
Advanced Program-to-Program Communication (APPC) for the Personal Computer (APPC/PC) allows workstations on a local area network to communicate with versions of APPC running in IBM System/370 or System/390, System/36 or 38, and 9370 hosts.

TCP/IP
Versions of TCP/IP run with operating systems and VM in hosts and network workstations. LANACS provides connections between:

- IBM PC Network Baseband workstations and a host using TCP/IP Telnet
- IBM PC Network Baseband workstations using TCP/IP Telnet and a host.

Asynchronous Communication
Products that provide asynchronous communication between LAN communication applications and remote non-SNA applications and devices, include:

- LANACS
- The IBM Asynchronous Communication Server Program
- The Remote NETBIOS Access Facility Program.

Part 3 of this manual describes products that provide higher level protocol and interface support for the IBM PC Network Baseband.

Chapter 5. Manufacturing Automation Protocol (MAP) Network

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Network Adapters 5-3
Data Transmission 5-3
Network Architecture 5-4
Protocols and Interfaces 5-4
Higher Layer Protocols 5-5
X.25 Packet Switching 5-5

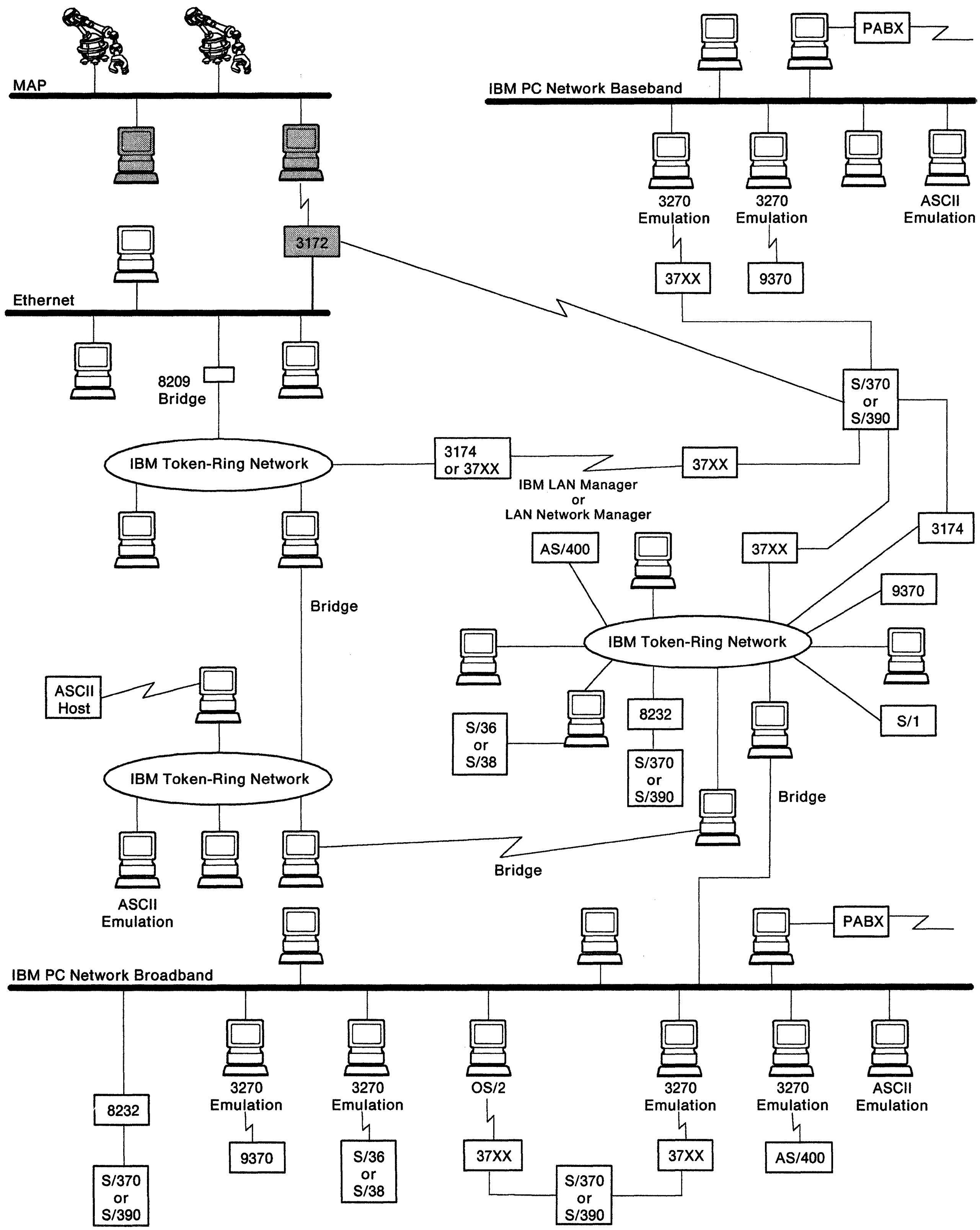

Figure 5-1. A Composite LAN Containing a MAP Segment

Overview of the MAP Network

Among the groups that have formed to address the development of network communications structures suitable for specific application areas is the Manufacturing Automation Protocol (MAP) task force, formed under the leadership of General Motors. The MAP task force specifically addresses the issues involved in factory automation.

The general structure of a MAP network is a hierarchically interconnected network consisting of:

- Local Area Networks
- Campus Networks
- Metropolitan Area Network (MAN)
- Wide Area Network (WAN).

Figure 5-1 highlights the MAP portion of a composite LAN.

At the lowest level of a MAP network are LANs providing direct communication at a single location, usually a single building or floor of a building. LANs are then interconnected to provide for communication over wider areas. A campus network connects networks over a wider range that LANs do but still in relatively close proximity. A MAN connects campus networks or more widely spread LANs, usually in the range of 5 to 50 km. A WAN is required for distances greater than 50 km.

Network Adapters

There is one IBM MAP adapter available, the IBM 3172 Interconnect Controller MAP adapter.

Data Transmission

A MAP network:

- Can use either a broadband or baseband transmission technique
  - A broadband MAP network transfers data at 10 Mbps.
  - A baseband MAP network transfers data at 5 Mbps.
- Uses the token-passing bus media access method.

Network Architecture

MAP uses the OSI reference model as a basis for its architecture.

The MAP architecture defines a selected set of protocols, with which the MAP network implements selected features. The selections of the MAP task force for each of the layers in the OSI architecture are shown in Table 5-1.

Table 5-1. MAP PROTOCOLS

OSI Layers	**MAP V2.1 Protocols**
Application Layer	ISO FTAM (DP) 8571 File Transfer Protocol, Manufacturing Messaging Format Standard (MMFS), and Common Application Service Elements (CASE)
Presentation Layer	NULL (ASCII and Binary Encoding)
Session Layer	ISO Session (IS) 8372 Basic Compiled Subset and Session Kernel, Full Duplex
Transport Layer	ISO Transport (IS) 8073 Class 4
Network Layer	ISO Internet (DIS) 8473 Connectionless and for X.25 - Subnetwork Dependent Convergence Protocol (SNDCP)
Data Link Layer	ISO Logical Link Control (DIS) 8802/2 (IEEE 802.2) Type 1, Class 1
Physical Layer*	ISO Token Passing Bus (DIS) 8802.2 (IEEE 802.4) Token Passing Bus Media Access Control

Note:

* Note that ISO is considering moving the IEEE-defined medium access control (MAC) sublayer of the data link layer to the physical layer. This move would make the MAC sublayer conformant with the OSI reference model.

Protocols and Interfaces

At the physical and data link layers, MAP uses IEEE 802 standards. IEEE 802.2 LLC protocols are used for data transfer, but only Type 1, connectionless service, is specified by MAP. With connectionless service, no sequence checking, message acknowledgment, flow control, or error recovery functions are performed at the data link layer. These functions are left to higher level layers. MAP does allow for the option of acknowledged connectionless service where a sending station transmits a frame and the receiving station acknowledges it with a response, thus allowing for detection of nondelivery and retransmission at the data link layer.

The IEEE 802.4 token bus standard is used for the MAP access control method. The physical layer supports baseband and broadband transmission techniques.

Higher Layer Protocols

The responsibility of each layer in the OSI architecture is shown in Table 5-1.

X.25 Packet Switching

Consideration has been made for the use of WAN services to interconnect with MAP LANs. For WAN services, MAP uses X.25 packet-switching. X.25 is a connection-oriented network, and MAP is a connectionless network. In a MAP implementation, the network layer provides for the mapping of one network service to the other.

Chapter 6. Ethernet Networks

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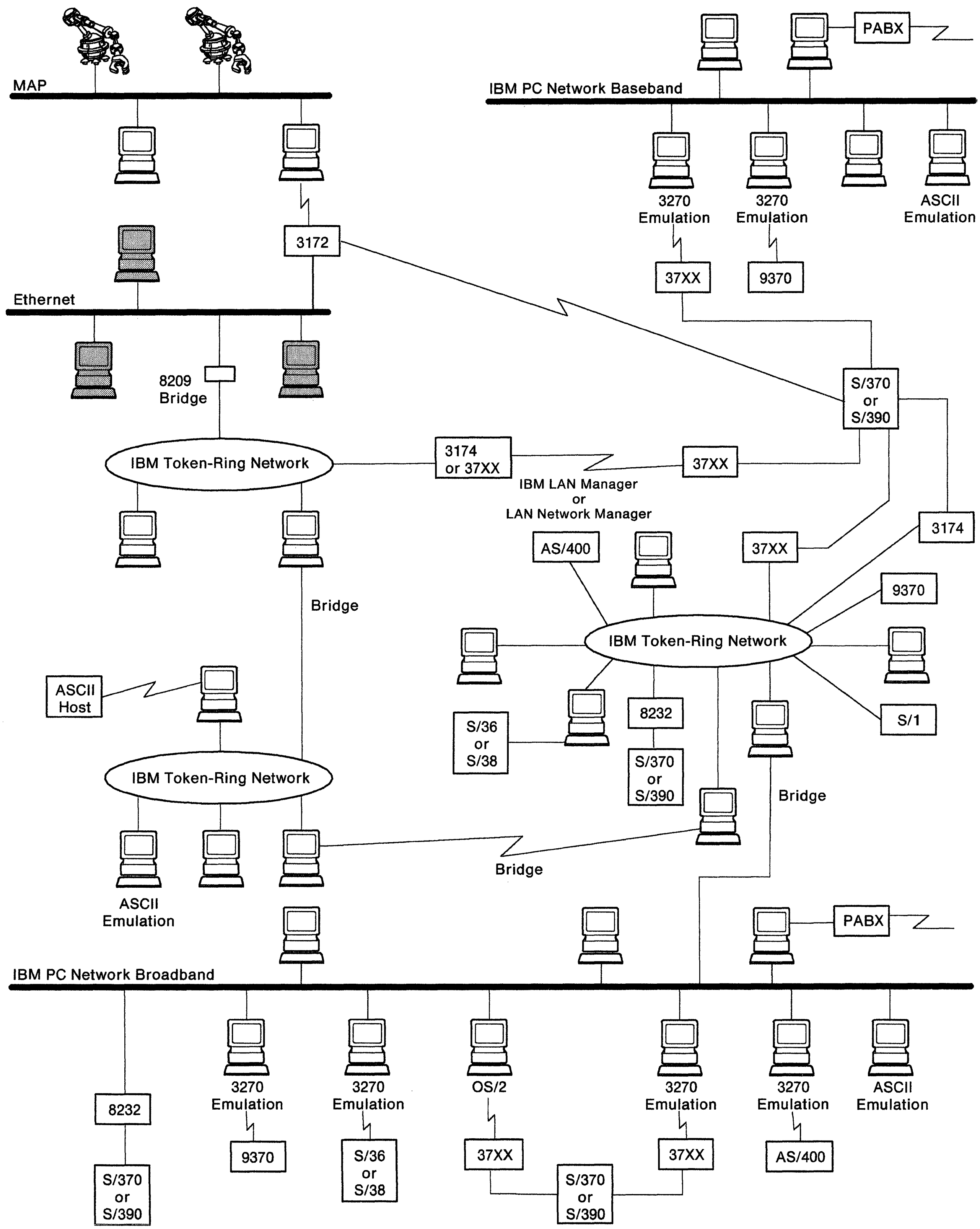

Figure 6-1. A Composite LAN Containing an Ethernet LAN Segment

Overview of Ethernet Networks

Ethernet is a network that uses a tree topology.

Figure 6-1 highlights the Ethernet portion of a composite LAN.

Ethernet is a multiaccess packet-switched network. Frames transmitted over the network reach all stations. Each station is responsible for recognizing the address in the frame and accepting only those frames addressed to it. Access to the transmission medium is controlled by the stations using a statistical scheme to gain control of the transmission medium.

Early versions of Ethernet specifications contributed to the work of the IEEE on the 802.3 standard defining the CSMA/CD access control method. The latest Ethernet specification is essentially an implementation of the MAC sublayer that is compatible with the IEEE 802.3 standard.

Hardware Components

Cable connects attaching devices to network connection points and to other attaching devices.

The most commonly used cable in an Ethernet network is coaxial cable. There are two types of coaxial cable available:

- Thick Ethernet cable is a relatively expensive coaxial cable used for early Ethernet implementations.
- Thin Ethernet cable is ordinary CATV-type coaxial cable used in later Ethernet installations.

Most recent Ethernet developments allow the use of twisted-pair cable to support a data transfer rate of up to 10 Mbps.

Transceivers implement the physical channel access function. The physical channel includes the logic on the adapter that does the encoding and decoding, preamble generation and removal, and carrier sensing. The transceiver contains the logic necessary to send and receive bits over the coaxial cable and to detect collisions. A transceiver may be present on the Ethernet adapter or may be connected to the adapter card.

Ethernet adapters are installed in each device on the network and enable communication and data exchange on the network. See "Network Adapters and Attachment Features" on page 6-4 for more about Ethernet adapters.

Software support programs and interfaces assist application programs and adapters to become a part of the network and exchange data with other application programs on the network. These programs provide functions such as:

- Protocol conversion
- Adapter or feature configuration
- Association between application program addressing and adapter or feature addressing
- Network access.

Network Adapters and Attachment Features

Each device that connects directly to an Ethernet Network must have a network adapter or attachment feature installed in it. Adapters plug into slots or positions in the attaching devices.

Listed below are IBM devices and Ethernet adapter combinations:

- IBM 3172 Interconnect Controller - IBM 3172 Interconnect Controller - Ethernet adapter
- IBM Personal System/2 computers with Micro Channel Architecture - Ethernet adapter
- IBM 8209 LAN Bridge - Ethernet/IEEE 802.3 attachment module.

Adapter Configurable Hardware Options

Hardware switches, jumpers, and software configuration parameters allow you to define or set configuration options for each adapter, in order to:

- Enable or disable adapter features and functions
- Assign values for adapter resource allocation
- Accommodate installation of multiple adapters in one device.

Workstation Adapters: Configurable hardware options allow you to define configuration parameters for each adapter, including:

- Which interrupt level is to be used to exchange processing control between the adapter and the device. The Ethernet adapter interrupt levels are 3, 4, 10, and 15. The interrupt levels cannot be shared.
- What address the computer is to use to access the adapter's static random-access memory (SRAM) and ROM for the Ethernet adapter.
- Whether ROM is enabled or disabled on the adapter.
- Whether Remote Program Load (RPL) is enabled or disabled on the adapter.

The IBM Ethernet Adapters may have jumpers or switches that must be set before installing an adapter in a computer.

The *Installation Instructions* packaged with each adapter explain how to set the options for the adapter. The publications for application programs that use adapters indicate any specific requirements for the settings.

The *Installation Instructions* packaged with each adapter also explain how to install the adapter and verify its operation.

Host and Controller Adapters and Attachment Features: Controllers and host computers access an Ethernet Network through workstations connected both to the network and to the host or controller. The connection to the host or controller can be a direct channel or a remote connection over a telecommunications link or public switched network. A controller connected to a workstation on the local area network may also connect directly or remotely to a host computer, thereby providing communication with the host for devices on the LAN.

Data Transmission

Ethernet:

- Transmits data at 10 Mbps
- Uses the baseband transmission technique

  Each transmitted message uses the entire signal bandwidth on the cable. One user at a time can transmit; another user cannot begin transmission until the first user has relinquished use of the physical medium.
- Uses CSMA/CD contention to access the transmission media

  Any device on the network may transmit at any time providing no other device is transmitting data. In the unlikely event that two devices start transmitting at the same time, both devices detect a collision of signals on the network and stop transmitting data. Each station sends a temporary jamming signal, waits a random length of time, and attempts the transmission again.

Transmission of Data on the Network

In order for an attaching device to communicate on the network, the device must contain:

- An operating system or subsystem
- A network adapter
- Cables to connect the adapter to the adjacent adapters or to connection hardware
- One or more application programs that can send and receive data on the network
- A support program or interface that handles communication between the adapter and the application programs. Although application programs can be written to communicate directly with the adapter, most require a support program. Part 3 of this manual describes support programs and interfaces used with an Ethernet segment of a LAN.

Each time the power for a device containing an IBM Ethernet adapter is turned on, a power-on self-test (POST) is executed from the adapter ROM to verify that:

- The adapter is operating correctly.
- There is a cable connecting the adapter to the network.
- A test message sent along the cable can pass through the cable and return unchanged.

Before beginning to communicate on the network, an adapter checks to see whether another adapter is already transmitting. If so, the adapter waits a random length of time and checks again. Once the adapter determines that no other adapter is transmitting, it transmits a frame. The adapter then checks the network to see if another adapter transmitted at the same time. If a collision occurs, both adapters stop transmitting, wait a random length of time, and attempt transmission again.

Network Architecture

The Ethernet architecture is an implementation of CSMA/CD protocols.

Adapter support software provides access to the network through the two levels of communication with network adapters:

- The direct interface, which provides
  - Basic adapter functions (the ability to open and close an adapter, obtain error status, and set addresses, for example).
  - Transmission of frames directly without LLC protocol assistance.
- The DLC interface, which provides
  - Connectionless communication between devices providing no guarantee of delivery (through the DLC Service Access Point interface). These are primarily datagram and broadcast messages.
  - Connection-oriented services using LLC protocol (through the DLC station interface).

The use of the DLC and direct interfaces and the DLC, LLC, and MAC protocols by IBM Ethernet adapter application and support programs for workstation adapters is described in the *IBM Local Area Network Technical Reference*.

Protocols and Interfaces

The Ethernet uses CSMA/CD protocols to control data flow. Ethernet adapters implement the protocols involved in transmitting and receiving frames, and in recognizing the condition of the network.

Frame formats are described briefly in the *IBM Local Area Network Technical Reference*. The formats of the routing information field, DLC header, and information field are described in more detail in the *IBM Token-Ring Network Architecture Reference*.

Higher Level Protocols and Interfaces

Ethernet supports products that use a number of the higher level protocols and interfaces described in "Higher Layer Protocols and Interfaces" on page 1-21.

Network Addressing

Ethernet provides for universally administered or locally administered addressing.

Ethernet Universally Administered Addresses

The XEROX Corporation provides blocks of addresses for use in Ethernet adapters. Each Ethernet adapter has a unique 48-bit universally administered address assigned to it at the time of manufacture.

Network Adapter Addresses

Ethernet adapters have a 48-bit universally administered address that is permanently encoded in the adapter's microcode when it is manufactured.

The IBM LAN Support Program, Version 1.2, OS/2 EE 1.3, and some network applications allow you to override the universally administered address with a locally administered address that you assign.

In communication with hosts and controllers through gateway workstations, there may be a requirement for adapter addresses to be assigned in a certain format or in a certain range of characters.

The documentation packaged with devices, adapters, and programs explains the address formats and values used by and required for each adapter.

Locally Administered Addressing

For local addressing, each station is assigned a unique number within the network. However this local address could be the same as the local address for another station on another network. In the case of interconnected networks, a unique network identifier must be included.

Note: Ethernet does not specify how the 48 bits of the address are used. Network-specific addressing is possible but the higher level network layers must implement it.

In addition to universally and locally administered (individual) addresses, IBM Ethernet adapters with their associated adapter support code also support the use of adapter group (multicast) addresses and functional addresses.

IEEE 802.3 Ethernet specifies locally administered addresses. OS/2 EE 1.3 and the IBM LAN Support Program Version 1.2 support local addresses.

Note: Ethernet DIX Version 2 does not specify locally administered addresses.

Ethernet Multicast Addressing

Ethernet supports the use of multicast addressing. A multicast address is associated with a group of stations. A multicast address is identified by the value 1 in the first bit of the address.

Stations have multicast mode set to on or off. If it is on, the station accepts any frame with multicast addresses. As with network-specific addresses, it is the responsibility of higher level network layers to determine if the station is part of the group for a particular multicast address.

Broadcast Addressing

Ethernet supports broadcast addresses. An address consisting of all 1 bits is defined as the broadcast address. Frames containing the broadcast address are received by all stations.

Names and Addresses

One or more assigned names or addresses identify most application programs, support programs, and interfaces for communication and data exchange.

Most names can be recognizable words or combinations of letters and numbers. Some programs can use the device's network adapter address as an identifying name. Other programs require names of a specific format or convention, which is different from adapter addresses.

Support programs and interfaces often use a table or list to associate an adapter address with a sending or receiving application program name or address. Many of these programs or interfaces provide a function or file with which you assign the required names to create the lists or tables.

You must determine from the documentation packaged with each program or interface the required format for the names and addresses, and how to assign them.

Application programs that use gateway connections to communicate with remote hosts and with other types of networks need particularly careful consideration, so that the names and addresses assigned provide compatibility and uniqueness where required.

Network Management Programs

The LAN Network Manager can monitor an Ethernet segment connected to a LAN by an IBM 8209 LAN Bridge. However, the IBM LAN Manager 2.0 does not recognize Ethernet as an Ethernet network, but as a CSMA/CD network. See Chapter 14 for a description of network management.

Problem Determination and Resolution

Recognizing, isolating, and resolving problems on an Ethernet network involves:

- Determining that there is a problem

  Indications of problems on an Ethernet network can come from three main sources:

  - A network user report that a device or application is no longer working, is not working normally, or is indicating an error condition.

    Providing training and assistance in the use of devices and programs on the network can minimize user errors. Establishing user problem-reporting procedures helps resolve problems quickly and preserves the indicators and other information needed for problem resolution.

  - A status or error indicator from a network management tool and call to you from the operator.

    The messages from the network management program should contain information about:

    - The type of LAN problem or condition reported by the alert.
    - The portion of the network involved (such as adapter addresses, or network names of stations or applications).
    - Recommended action to resolve the problem or condition. The recommended action often includes or consists of an instruction to call the administrator of the LAN, so that problem resolution can be done at the problem location.

  - Analysis of utilization information.

- Determining the nature of the problem

  Reported symptoms and status and error information will help you determine the type or nature of the problem.

  The nature of the problem usually indicates the tools and procedures that must be used to isolate and resolve the problem.

  You will need to determine:

  – Whether the problem is a hard or soft error, a hardware or software error, or a user error.

  – What portion and component of the network is having the problem; a user, a program, a device, a network adapter, or another network component.

- Using the required tools and procedures to resolve the problem

  – Users may require instructions or other assistance in use of programs and devices on the network.

  – User's guides, operator's guides, and reference manuals packaged with programs, devices, and network components describe actions and procedures to use to correct malfunctions.

  – Diagnostic tests help you isolate a problem to the failing hardware or software.

    POSTs, which run each time the workstation power is turned on or the computer is restarted, indicate an adapter malfunction and a continuous or no carrier condition.

  – Network layout charts, building floor plans, and address-to-physical location charts help you locate failing components. You can create them yourself, or have your professional network designer create them while your network is being installed.

  – You will need to put procedures in place in your establishment for locating problems, removing portions of the network while problems are resolved, and returning portions of the network back to operation.

Chapter 10 contains more information about user training and assistance. Chapter 11 discusses LAN problem reporting and resolution in more detail.

Interconnection

There are IBM products for use on the Ethernet network that support:

- Gateways to hosts and other types of networks
- Remote connections to devices not directly connected to the network.

Bridging Products
The IBM 8209 LAN Bridge with an Ethernet/IEEE 802.3 attachment module can connect an Ethernet network to a Token-Ring Network. Chapter 15 describes bridging products.

Gateways
The IBM 3172 Interconnect Controller with appropriate software and adapters can provide gateway connections to a variety of controllers and hosts. (Gateway functions are usually included in programs that provide 3270 emulation, APPC support, and asynchronous communication.) The IBM LAN to LAN Wide Area Network Program can also provide gateway connections to a telecommunications network.

OS/2 EE 1.3 includes support for an SNA gateway for 3270 and APPC that supports Ethernet as a downstream connection.

Chapter 16 describes IBM LAN products that provide gateway connections.

Remote Connections
LANACS provides asynchronous communication server functions to allow Ethernet communication applications to communicate with the following devices not directly connected to the network:

- LANACS (Version 2.0 only)
- IBM Remote NETBIOS Access Facility Program.

The remote device may actually be close enough to connect directly to the LAN, but cannot support the network protocols. If the device is too far away for a direct connection, the connection is made through a PABX, CBX, or public switched network.

Chapter 16 describes the programs that provide asynchronous communication server functions.

Network Software

The software used in devices that connect to an Ethernet includes:

- Application programs
- Operating systems and subsystems
- Support programs and interfaces.

Application Programs

Application programs that communicate over an Ethernet network vary with the work to be accomplished.

Application programs that provide services on the network include:

- Interconnecting LAN segments
  - IBM LAN to LAN Wide Area Network Program
  - IBM 8209 LAN Bridge with an ETHERNER/IEEE 802.3 attachment module.
- Messaging, server, and resource-sharing functions
  - IBM PC LAN Program
  - IBM OS/2 LAN Server Program
  - IBM Personal Services/PC
- Asynchronous communication servers
  - IBM Local Area Network Asynchronous Connection Server Program (Version 2.0 only)
  - IBM Remote NETBIOS Access Facility Program.

Chapter 14, Chapter 15, and Chapter 16 describe application programs that provide network services.

Operating Systems and Subsystems

IBM PC DOS, IBM OS/2 EE 1.3 in DOS mode, and AIX are the operating systems that run in workstations that connect to an Ethernet network.

The products that use the network may require the features and support provided by a particular operating system at a particular level or version. The descriptions on the product packages and the publications included in the packages indicate the operating system requirements for the product, including:

- Which operating system to use
- Level or version
- System, data, configuration, and batch file formats and contents
- Program load commands and parameters.

Host computers and controllers access an Ethernet network through workstations connected both to the network and to the host or controller. Host operating systems and the control programs or subsystems that run in controllers may provide or require particular configurations, features, or program packages to support communication with devices and application programs on the Ethernet network. The publications associated with the hosts and controllers and with the application programs that communicate over the network describe the requirements for such communication.

Chapter 17 describes operating systems and subsystems that run in devices connected directly to the Ethernet network and in hosts and controllers that access the network through workstations.

Support Programs and Interfaces

A number of IBM products provide adapter, protocol, and interface support for devices and application programs that use the Ethernet network.

Adapter Support

The IBM LAN Support Program, Version 1.3 provides adapter support for Ethernet adapters with their respective NDIS device drivers. In an OS/2 environment, the adapter support function is included in OS/2 EE1.3. Chapter 12 describes this program.

Higher Level Protocols and Interfaces

A number of IBM products provide higher level protocols and interfaces for the Ethernet network.

NETBIOS
The IBM LAN Support Program provides both NETBIOS and IEEE 802.2 interface support to programs and adapters in network workstations.

The IBM PC LAN Program uses the NETBIOS interface to provide network message, print server, and file server functions.

Part 3 of this manual describes products that provide higher level protocol and interface support for Ethernet.

Device Emulation
LANACS provides 3270 device emulation for Ethernet workstations, and gateway functions for IBM TCP/IP host connections.

TCP/IP
Versions of TCP/IP run with operating systems and VM in hosts and network workstations. LANACS provides connections between:

- Ethernet workstations and a host using TCP/IP Telnet
- Ethernet workstations using TCP/IP Telnet and a host.

Part 2 — Network Administration

Chapter 7. The Role of the Network Administrator

The Network Administrator 7-3

The Network Administrator

The local area network administrator has the primary responsibility of managing the daily operation and workload of one or more LAN segments or of an entire network. Sometimes this person also participates in planning, installation, and problem resolution for the network.

If your network is small (consisting of one LAN segment or several small LAN segments), one network administrator may be sufficient. If your network is large, either in size (multiple LAN segments) or in geographical area (several floors, buildings, or geographical locations), your organization may consider having several administrators. A *local* administrator can oversee day-to-day activities at each LAN segment or site. One *network* administrator at a central site can coordinate planning and more global activities.

A local administrator might:

- Provide user education and assistance on use and operation of network devices and application programs
- Prepare and replace working copies of software
- Perform initial or preliminary problem resolution, and call for additional assistance, if required
- Give information to the network administrator and planner about network requirements.

The network administrator might:

- Coordinate the activities of local administrators
- Work with the network planner on network layout, hardware and software installation for a new network, or for modifications to an existing network
- Evaluate and select software used on the network
- Assign addresses, names, and identifiers used in network communication and labeling, to assure their uniqueness across the network
- Create an establishment problem resolution procedure
- Participate in resolving more difficult network problems, and obtain outside assistance, if required
- Participate in hardware and software design and installation of connections between LAN segments and between a LAN and another type of network.

Notes:

1. From this point on, the term "network administrator" will be used to refer to both the local and network administrators.
2. Although this manual refers to a network administrator and a network planner, the activities of each may be performed by the same person, two people, or several people.

As a network administrator, you will need a thorough understanding of:

- The user requirements and objectives of your establishment

  This may come from work experience, or from discussions with other employees about your establishment's current operation and requirements.

- LAN concepts and operation

  - *An Introduction to Local Area Networks* and Chapter 1 of this manual describe LAN concepts in general.
  - Part 1 of this manual contains overviews of specific LANs.
  - Publications listed in Appendix A describe the architecture, planning, installation, and operation of IBM LANs.

- Concepts, use, and operation of the attaching products used in the network

  Most hardware and software products used on LANs are packaged with publications that describe:

  - Configuration and installation
  - Features, functions, and operation on the network
  - Use (keys, menus, responses, access, and termination, for example)
  - Problem resolution information and procedures.

Part 2 of this manual identifies activities helpful to the network administrator, but does not explain *how* to perform these tasks and activities. It does:

- Suggest tasks and activities that you might perform as an administrator
- Cite considerations to keep in mind as you perform the tasks and activities
- Refer to other documents and publications that contain more detailed information about the tasks and activities (including how to do them).

The suggested tasks, activities, and considerations are not necessarily a complete list for your establishment. You may add or delete items as appropriate for the requirements of your network and establishment.

Chapter 8. Network Planning

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Determining Network Objectives and Requirements

In order to choose, plan for, and install an appropriate LAN for your establishment, you must first determine what you want to accomplish using the network.

Then, you and the network planner must identify what network hardware peripheral equipment, network software, and application software your objectives require.

Network Objectives

To identify the objectives to be accomplished by your network, you need to determine:

- What tasks are currently performed, and how they are accomplished. For example
  - Accounting, billing, sales, and inventory information may be shared by hand-carrying printed reports and data files on diskettes from one department to another.
  - Checks, sales orders, and other documents may be hand-written, requiring separate data entry for record-keeping.
  - Printers, plotters, and other peripheral equipment can be used only by the applications on the computers to which they are connected.
- What tasks are needed by the establishment but are not currently performed. For example
  - Data files need to be transferred to a host computer in another city or state.
  - Reports need to be formatted by programs from information in shared data files, rather than being typed from hand-prepared input.
  - Use of electronic messaging and mail, instead of hand-prepared messages and memos being delivered between individuals and departments and kept in file cabinets for reference.

You may need to change the way some things are currently done, do some new things, and perhaps continue doing some things the same way. Your objectives for using a LAN might include:

- Replacing hand-carrying of information from one department to another with
  - Data and print file transfer across the network
  - Sharing of common files and databases
- Sharing printers and other peripheral I/O equipment among all network users
- Sharing and maintaining programs and tools from a central library
- Providing user access from the LAN to large host computers on wide area networks
- Providing electronic messaging and mail for network users.

Network Requirements

Once you have identified the objectives for your network, you need to identify the hardware and software components required to accomplish your objectives.

Your establishment may already use individual personal computers, host computers, peripheral equipment, and programs to perform such tasks as payroll, accounting, billing, inventory or process control, word processing, and sales order processing.

You may be able to use some or all of the existing equipment and programs in the network. You may need to add new equipment and programs, or replace or modify some existing ones to meet your network requirements.

Application Software

For each task in your objectives, you need to identify the application programs required to accomplish the task. The programs you choose will have requirements for hardware, support programs, and network resources in order to operate correctly and efficiently.

Network Hardware

You need to determine:

- The device or combination of devices required by the application programs you choose to accomplish each task in your objectives.
- The hardware components, described in Part 1 of this manual, required to connect the devices into a network and enable them to communicate.

  You need to identify:

  - The number and type of network adapters or attachment features required by each device that connects directly to one or more LAN segments
  - The connection point to the network for each network adapter
  - Conversion and regeneration components you may need to extend the allowed distance between devices or connection points
  - What links, modems, and other data communication equipment are needed for remote connections.

Network Software

You need to decide what software your network requires to:

- Provide support for network adapter operation and communication
- Provide the interfaces and protocols required by the application programs used in your network
- Provide network services to users and programs, including electronic mail, messaging, file and print servers, asynchronous communication, bridging, network management, and problem resolution.

Peripheral Equipment
Your establishment may have or need printers, plotters, tape drives, and other peripheral equipment that, without the network, are accessible only to the users connected to the same computer with the device. The network can enable sharing of such devices among many or all network users.

You need to decide which peripheral devices your network needs, and where to place them in the network.

Planning the Network Layout

The network planner has the primary responsibility for the physical organization and location of the network. As the network administrator, you will be requested to participate in some of those planning activities.

You will need to provide information to the network planner about the work the network must accomplish, as this may affect the physical layout of the network. As the network administrator, your knowledge of the work to be done on the network is needed to make decisions about:

- Size of the network
  - How many and what kind of devices are required
- Placement of devices, programs, and peripheral equipment
  - Which devices to connect to which LAN segment
- Connections between LAN segments
  - Which LAN segments to connect with bridging products
- Remote connections to devices and other networks
  - Which devices provide gateway and communication server functions; which stations need to communicate with hosts, controllers, and remote devices.

Size of the Network

A single LAN segment usually has a maximum number of devices that can be connected to it. If the number of devices connected directly to LAN segments in your network exceeds the maximum for one LAN segment, your network must consist of two or more LAN segments.

Even though devices and application programs may be located on different LAN segments, they may still need to communicate with each other, or may need a service or resource from another LAN segment. Connecting the LAN segments with bridging products enables such devices and programs to accomplish the required communication. If connection-oriented communication is used, the processing time to send a frame across several bridges, receive the frame, and return the acknowledgement of receipt to the sender may exceed that allowed by the protocols and interfaces used to accomplish the transmission. You may want to limit the number of bridges that most frames will cross in a network to fewer than seven (the maximum number allowed).

Other considerations for determining the number of LAN segments in your network and the number of devices connected to each LAN segment include the following:

- You may want to use several LAN segments to group devices according to task, function, or geographical location, even though the total number of devices could connect to fewer LAN segments than the number used in such groupings.
- The expected growth of your network would require some LAN segments to be split in the near future. You may want to create additional LAN segments in anticipation of the growth.

- You may want a centrally located backbone LAN segment to provide network access to hosts, servers, printers, and other shared resources.
- In order to keep average LAN segment utilization below 30% to allow for growth and occasional traffic peaks, you may want to group together on separate LAN segments application programs that exchange information in large volumes at one time or in continual shorter messages over long periods of time.

Placement of Devices and Network Components

As you define what is required to accomplish the objectives for your network and determine the types and numbers of devices and other components needed, you and the network planner then begin to envision the physical and logical placement of each device, component, and program in the network.

You need to decide not only what resides on each LAN segment and which LAN segments must be connected, but where to locate each component physically in your establishment.

Single LAN Segments

In determining what to place on each LAN segment, some factors for placing devices and programs on the same LAN segment include:

- Frequency or volume of information exchange
- Shared files or peripheral devices
- Similarity or dependency in tasks to accomplish
- Geographical location
- Central location of services, host and controller connections, or remote connections.

A single LAN segment that is not connected to any other LAN segment, network, or remote device must contain the components needed to be self-sufficient in network management, services, resources, and problem resolution.

Connecting Two or More LAN Segments

Multi-segment networks can share the components that provide network management, services, resources, and problem resolution. They do not require self-sufficiency on every LAN segment.

You may want to connect two or more LAN segments so that devices on the connected LAN segments can:

- Share a single peripheral device (such as a printer)
- Access a gateway connection to a host
- Share application programs, software tools, and data files from a server
- Participate in providing network management and problem resolution information to a central station or host.

If you are helping to plan a multiple-LAN segment network, you must also consider the overall performance of the network and the configuration demands placed upon it by the application programs that you will be using. The general goal is to provide communication between two programs, devices, or users either over the shortest possible geographical distance, or with the shortest possible time delay, or both.

In deciding how many and which LAN segments to connect with bridging products, consider the following:

- Frames sent to one specific destination (non-broadcast frames) can cross a maximum of seven bridges that use IBM bridging products.

  The routing information field in a frame defines the route a frame takes to its destination by listing the bridges that the frame crosses on the route. The routing information field has space to define a maximum of seven bridges.

  Although a frame can travel across up to seven bridges in a network, most paths will contain fewer than seven bridges. If connection-oriented communication is used, the processing time to send a frame across several bridges, receive the frame, and return the acknowledgment of receipt to the sender may exceed that allowed by the protocols and interfaces used to accomplish the transmission.

- The hop count limit and single-route broadcast functions of IBM bridging products can help limit the proliferation of broadcast and single-route broadcast traffic across the network.

  The hop count limit function of IBM bridging products limits to seven or fewer the number of bridges that broadcast frames (and single-route broadcast frames in certain versions of the bridging products) can cross.

  A broadcast frame that has crossed a number of bridges equal to or greater than a bridge's assigned hop count limit cannot be forwarded across that bridge.

  The single-route broadcast function of IBM bridging products is used to ensure that there is a single path through intermediate LAN segments for single-route broadcast frames sent between any two LAN segments in a network. The NETBIOS interface and APPC use single-route broadcast frames and responses to obtain the route between a sender and receiver in a multi-segment network. These interfaces expect only a single copy of each single-route broadcast frame arriving at each LAN segment.

  Only the bridges that have the single-route broadcast function active will forward single-route broadcast frames across the bridge. Thus a single copy of any single-route broadcast frame reaches each LAN segment.

- Spanning-tree protocols used by Ethernet networks ensure a single path between any two Ethernet LAN segments in a network.

- You can use bridges to connect multiple LAN segments to a central backbone LAN segment.

  The backbone LAN segment can:

  – Provide the most direct access to shared devices (such as print and file servers or host computers) that are on the backbone LAN segment

  – Allow placement of gateway, host computer, controller, and remote connections on the backbone ring, giving the system administrator the freedom to route new application communications to whichever communication connection is most appropriate, unless otherwise constrained

  – Provide the shortest average path between any two attaching devices on the network

  – You may choose to use the IBM LAN to LAN Wide Area Network Program instead of a bridging product, to connect LANS through your wide area network.

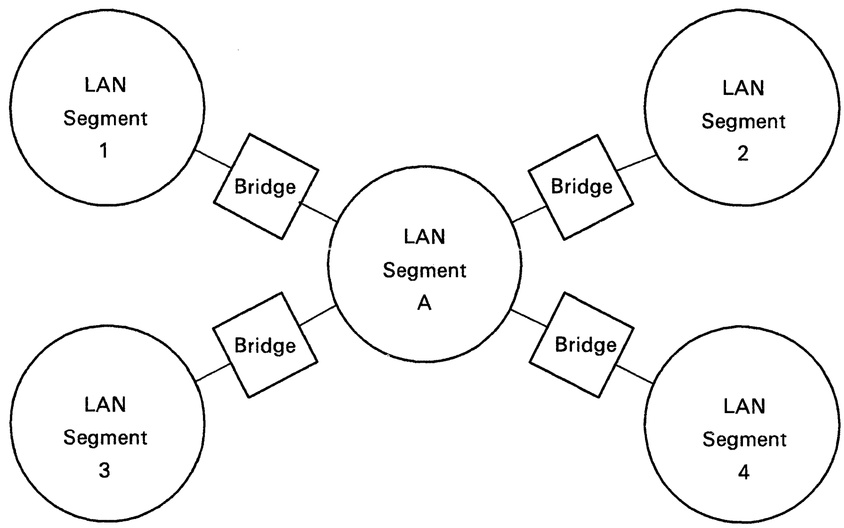

Figure 8-1. A Backbone Connection

Gateway, Host Computer, Controller, and Remote Connections

You may combine programs and devices to provide gateway connections between devices or networks that use different protocols and interfaces. Some gateway devices accept information formatted for only one protocol or interface. The application programs that use the gateway must accomplish any required protocol or interface conversion. Other gateway devices and programs perform such conversion as part of the gateway function.

Some hosts and controllers can connect directly to a LAN. The host operating system, host or controller subsystems, and support programs provide adapter, protocol, and interface support. Other hosts and controllers access a LAN through a gateway device or through an intermediary network workstation. Such hosts and controllers might connect directly to the gateway device or the intermediary device. There could also be a remote connection over a private or public telecommunications link between a host or controller and the gateway or intermediary device. The host, the controller, and the stations on the network that communicate with or through them may need corresponding interface or protocol support programs.

Remote connections may also exist between stations on the network and devices that cannot connect directly to the network. These devices might use different protocols or interfaces than those used on the network, or might be too far away from the network to connect directly.

Two major considerations in including gateways, host computers and controllers, and remote connections in a network are:

1. Make sure the devices are running the required programs that provide protocol and interface support and conversion.
2. For connections made using telecommunications links, evaluate carefully the volume and characteristics (frame size, sporadic large file transmission, frequent or constant small file or message transmission) of the traffic that uses the link. Telecommunication line data rates are generally lower than LAN data rates, and quality of transmission varies with the line data rate and the type of line.

   Select a link with an appropriate line data rate and transmission quality required by the application programs that will use the link. You may also need to limit the number of users or the amount of traffic that can access the link at the same time.

For more information about:

- Gateway devices and programs, see Chapter 16
- Host computer and controller access to LANs, see Chapter 16
- Remote connection programs, see Chapter 16.

Network Tools

In the placement of devices in the network that are used exclusively or primarily for network management, monitoring, or problem determination (network manager programs, trace programs, performance monitors, diagnostic tools, and so on), consider that some of these programs and tools:

- Require dedicated devices
- Get information only from the LAN segment on which they operate
- Can receive information from several LAN segments or the entire network through bridges and other network connections
- Run continuously while the network is operating
- Run only when needed for a specific purpose (traces or problem determination, for example).

You need to determine where in the network such programs and tools should be placed for:

- Access to network connection points
- Convenient location to you and other operators for continuous or as needed use
- Security from unauthorized use.

Testing and Development

You may want to include in the design of your network one or two small LAN segments consisting of several attaching devices and the appropriate hardware components (cables and one access or translator unit, for example). These LAN segments could be used, either as needed or continuously, for:

- Testing new or modified application programs before they are installed in your network
- Writing and testing your own application programs and support programs
- Creating and verifying user and operator procedures and instructions for devices and application programs
- User and operator training and demonstrations
- Problem resolution.

The equipment for these small LAN segments could be borrowed from your large network as needed (with the appropriate planning in advance), or dedicated to development and test. Having such a LAN segment with which to experiment and test can lessen disruption of your large or production network.

The *IBM Token-Ring Network Guide for Small Networks* describes how to plan and install an IBM Token-Ring Network of less than 96 stations using access units and patch cables.

The *IBM Token-Ring Network Starter Kit Guide*[1] describes how to install and verify the operation of a small ring of two to eight stations.

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[1] The *IBM Token-Ring Network Starter Kit Guide* is no longer available from IBM.

The *IBM PC Network Broadband Planning Guide* describes how to construct a small IBM PC Network Broadband of up to 72 stations using IBM Cable Kits and appropriate network adapters.

The *IBM PC Network Baseband Planning Guide* describes how to construct a small IBM PC Network Baseband by serially connecting the network adapters in up to eight stations.

Labeling Network Components

As the network planner designs the physical network, you may assist him in establishing a method of labeling the components of the network. The labels include numbers and/or names identifying the devices and cable connections in the network and the physical locations of the components. As you assign these names or numbers, write them on adhesive labels. At installation time you provide the labels to the person doing the installation, who affixes them to new or replacement hardware components.

If the labeling system decided upon for your network is not the one described in the IBM Cabling System or LAN documentation, you may be asked to explain the system to those persons doing installation or resolving problems in the network. They will have difficulty following installation and problem determination procedures without an understanding of your labeling scheme.

The *IBM Cabling System Planning and Installation Guide* describes a labeling scheme for connections to building wiring and equipment in racks.

The *IBM Token-Ring Network Introduction and Planning Guide* explains an adaptation of the IBM Cabling System labeling scheme for the IBM Token-Ring Network.

For IBM PC Networks, you can create your own scheme as you install small networks, or have your professional network designer/planner label the components as your network is installed.

Some considerations in creating or choosing a labeling scheme are:

- Identify each hardware component and device uniquely and meaningfully with a name and/or number.

  Meaningful identification should allow you to determine quickly the physical location (room or office and floor, for example), type of component, and type of installation (rack, adapter in a computer, faceplate connection, or network connection point, for example). Rapid identification and location of components can hasten problem resolution, and ease the changing of the network layout temporarily or permanently.

- Identify the connection points of both ends of each cable used in your network, whether the cable is building wiring installed in walls, patch cables, adapter cables, or any other physical medium.

- Use the labeling scheme on the components themselves, and to identify the components on the charts and worksheets in your network documentation.

Documenting the Network Organization and Layout

In addition to labeling the components and connections in your network, you and the network planner should create and maintain charts or other documents showing the physical layout of your network.

These documents may be used for and crucial to:

- Correctly installing a new network or LAN segment
- Quickly locating and resolving network hardware and software problems
- Changing the physical layout of your network after its original installation.

You should preserve your network documentation, and keep it accurate by updating it every time you make a change in your network.

For a very small network, this could be as simple as writing the names or numbers from your labels on the appropriate positions on a building or floor plan.

For larger networks, you may use charts and worksheets to record various types of information, including:

- Contents of equipment racks and wiring closets
- The sequence in which devices and hardware components are cabled together (including physical locations of cables and cable connection points)
- Names, addresses, and other identifiers used by devices, components, and programs, matched with their physical locations (one list in identifier sequence, and one list in location sequence)
- Equipment ordering and inventory worksheets, for original and replacement parts and components.

The *IBM Token-Ring Network Introduction and Planning Guide* contains and describes several planning charts to use in documenting an IBM Token-Ring Network.

You can create your own charts or have your professional network designer create them for an IBM PC Network. Refer to the *IBM PC Network Broadband Planning Guide* and the *IBM PC Network Baseband Planning Guide* for information about planning an IBM PC Network.

The *IBM Cabling System Planning and Installation Guide* contains charts and methods to use in labeling and documenting LAN cable connections.

Providing Spare Components

As the network is created or modified, the network planner must determine how many of each network component to order. The totals will include spare components to replace any found to be defective during installation or problem analysis. These components may include cables, access and translator units, repeaters, and network adapters.

The person who is installing the network hardware should contact you for a replacement if he detects a faulty network component during installation. He may also need spare cables or other components for testing or replacement as the network is installed and verified to be operating correctly.

Problem determination procedures may require spare cables for testing and replacement to resolve problems. You and the network planner may decide to order spares of other network components, to keep your entire network operating while faulty components are being repaired or replaced.

You will need to provide:

- Storage space for the spare components
- A method of inventory control for them
- A procedure for replacing them as they are used.

Stocking, control, and replacement of spare parts becomes more complex as your network spans more physical territory, including connections of LAN segments to hosts and subsystems located across town or in another city or state. Network planners and administrators in several locations may need to coordinate the management of spare parts requirements and availability at each network location.

Preparing for Hardware Installation

Network hardware installation includes:

- Installing network adapters in attaching devices (if the adapters were not installed when the device was manufactured)
- Connecting adapters to network connection points with cables
- Connecting access units or other connection hardware to form LAN segments
- Placing conversion and regeneration units where they are needed to convert signals from one medium to another and to extend the distance that one network can cover
- Connecting LAN segments to form a network
- Verifying the operation of each device, each LAN segment, and the network.

Preparing for Adapter Installation

Each device that attaches directly to a LAN must have at least one network adapter or similar attachment feature installed in it that physically connects the device to a LAN segment.

Publications packaged with and relating to adapters, devices, and application programs explain:

- How many and which types of network adapters, attachment features, and other adapters can be used together in a device
- What positions or slots in the device can be used for network adapters
- Which adapters are required for an application program
- Which support programs and files are required for each adapter.

Before adapters are installed in attaching devices, the planning and preparation required includes the following activities:

- Determine the hardware, support program configuration, and support program load command parameters for each adapter in each device.

  For all of the adapters installed in a device, the parameters must be set in hardware switches or jumpers, support program configuration files, and program load commands so that:

  - The appropriate adapter features or functions are enabled or inhibited
  - The features, functions, and parameters for all the different adapters in a device do not conflict with each other
  - The device, the adapters, and the application programs running in the device can communicate and share resources as required.

  See the chapters in Part 1 of this manual for more information about network adapter parameter values.

- Determine the addressing requirements for each adapter in the network.

  Determine whether to use a universally or locally administered address for each LAN adapter in the network. Some application programs require the user to specify addresses in specific formats other than 12 hexadecimal digits; the program converts the specified addresses to 12-digit hexadecimal adapter addresses for use on the network. Locally administered addresses in the required format must be used for these adapters.

  See "Addressing in the Network" on page 8-17 for more information about adapter addresses.

  Some application and support programs are able to recognize universally administered adapter addresses as they are; others require specific formats or value ranges. Some programs require separate program names and addresses in a different format, and use a table to correlate program and adapter addresses.

- Prepare working copies of support programs and files.

  Determine which support programs and files are required by each adapter in the network. You may need them to:

  - Complete the specification of adapter parameter values
  - Verify correct operation of the network once the adapters are installed and installation is complete.

  Programs for workstations are usually supplied on diskettes. For programs and files supplied on diskettes, each program and file must be copied from the original diskettes to a working fixed disk or diskette, along with any other required files. A working disk or diskette then contains the required levels and combination of operating system programs and files, interfaces and support programs, application programs, configuration files, batch files, load files, and data files.

  Programs and files used by controllers and hosts may come on diskettes or magnetic tapes. The programs and files are usually copied to working disk files, though some of the magnetic tape files can be used directly from the tape. These programs and files are generally used as input to a process (such as system generation or compilation) that prepares the programs and files used in the attaching device.

  For more details on preparing working copies, see:

  - "Preparing Working Copies of Programs and Files" on page 8-25
  - "Preparing Programs for Workstations" on page 9-11.

Addressing in the Network

One of your primary activities as network administrator is managing the addressing used in your network.

Address administration in the network involves making sure that:

- Each adapter, program, and interface that communicates on the network has the required names and addresses assigned in the correct formats
- For names and addresses that require it, each name and address is unique in the network.

Note: In this discussion, *network* refers to all LAN segments, off-LAN devices, and other types of networks between which communication can occur. One LAN can include devices, LAN segments, and connections to other types of networks in the same establishment and in different buildings, cities, states and countries.

Planning for network address administration includes the following activities:

- Determine whether to use universally or locally administered adapter addresses.
- Determine the formats and valid values for the addresses of adapters and features that require a format other than 12 hexadecimal digits.
- Determine the formats and conventions required for names and addresses used by application programs, support programs, and interfaces to communicate on the network.
- Assign and document network names and addresses. Be sure that:
  - Addresses are unique where required across the network
  - Locally administered addresses are within the valid range for the adapters and programs that use them
  - Names and addresses are compatible for communication across different types of networks and applications.
- Create guidelines and procedures for changing names and addresses in the network, and for updating the documentation as such changes are made.
- Anticipate future network growth and change as you assign network addresses and names.
  - Assigning unique addresses where required across all LAN segments, whether the LAN segments are presently joined with bridging products or not, makes it possible to join LAN segments in the future without having to reassign addresses to eliminate duplicates.
  - Assigning locally administered addresses and duplicate addresses where permitted allows application programs to be moved to different devices and allows devices to be moved from one LAN segment to another without having to reassign addresses or change program and device configuration parameters.

Network Adapter Addresses

Network adapters used in IBM LANs each require a universally or locally administered adapter address. The adapters support the use of group addresses and functional addresses that are assigned, enabled, or disabled by support and application programs that use the adapters to communicate on the network. (See "Network Adapter Addresses" on page 1-25 for more information about adapter addresses.)

Universally and Locally Administered Addresses

For most network adapters, you need to decide whether to use the adapter's universally administered address or to assign a unique locally administered address.

You might choose to use locally administered addresses to more easily:

- Identify adapters, by assigning sequential values to related groups of adapters
- Identify use of a device or an application program, by assigning values that have significance in your establishment (such as location, cabling, user, or application program identifiers)
- Associate names and addresses on the network, by assigning compatible values to the locally administered address and to the name or address used to identify an application program, support program, or interface on the network (for those programs and interfaces that require specifying fewer than 12 hexadecimal digits, the program converts the specified value to a 12-digit address for use on the network)
- Replace adapters, without having to modify programs or rerun system or subsystem generations for programs that recognize adapter addresses
- Include or exclude single addresses or ranges of addresses when specifying the criteria by which filter programs decide whether a frame should be forwarded through a bridge that uses the remote bridge function.

The documentation packaged with each program or interface should indicate whether locally administered adapter addresses can be used or are required by the program or interface.

Group Addresses

Group addresses allow a program or interface to send one *broadcast* message that will be received by all attaching devices having the same group address, instead of sending the same message to each adapter individually. Each program that expects to receive messages sent to a group address must enable that group address on its own adapter. The *IBM Local Area Network Technical Reference* explains how to use group addresses in programs that you write.

Functional Addresses
Some programs and interfaces enable or disable functional addresses on adapters, based upon the values specified for configuration or load parameters. You need to decide what values to specify for these parameters, to provide or request the appropriate services for these programs and interfaces in your network. The publications packaged with each program and interface explain the parameters that can be specified. The *IBM Token-Ring Network Architecture Reference* and the *IBM Local Area Network Technical Reference* explain the use, format, and bit assignments of functional addresses in programs that you write.

Recording Adapter Addresses

As you determine the adapter addressing to use in your network, work with the network planner to record adapter addresses and associate the addresses with the physical location of each adapter. This association aids in locating a failing device or adapter during problem analysis and resolution.

If your network uses any universally administered addresses, or if you want to record the universally administered addresses even if they are not used while the network is running, you cannot obtain the universally administered addresses until the adapters are installed. The adapter installation instructions include running an adapter diagnostic test to verify that the adapter is operating correctly after installation. The diagnostic test displays the universally administered address, which you can record at that time.

Note: The universally administered adapter address is **NOT** the serial number of the adapter card, which appears on its surface.

You can assign and record locally administered adapter addresses before the adapters are installed. The locally administered address is specified as a program or interface load or configuration parameter during software installation. You need to provide the locally administered addresses to the person who will prepare the working copies of configuration and parameter files during software installation.

Because the programs that set locally administered addresses can be moved to a different attaching device, you may want to create and maintain charts or labels relating the universally administered address of an attaching device's adapter to the locally administered address it is currently using. This may be useful in problem determination; programs that display the adapter address as part of error information will display the address that is currently being used by that adapter. For example, the Ring Diagnostic and the IBM LAN Manager display locally administered adapter addresses if they are being used. The Adapter Diagnostics and Advanced Diagnostics display only the universally administered address.

See "Installing Network Adapters in Attaching Devices" on page 9-3 for more information about installing adapters, using load commands, and using locally administered addresses.

Names and Addresses

One or more assigned names and addresses identify most application programs, support programs, and interfaces for communication and data exchange.

Generally, each program or interface contains a table or list of:

- The name or names by which it and its functions or services are identified by other programs and interfaces on the network
- The name or names by which it can identify other programs and interfaces on the network, and their functions or services.

Most names can be recognizable words or combinations of letters and numbers. Some programs can use the device's network adapter address as an identifying name. Other programs require names of a specific format or convention, which is different from adapter addresses. A table or list is also used to correlate a program name with the address of the adapter the program uses to communicate on the network. Many of these programs or interfaces provide a function or file with which you assign the required names to create the lists or tables.

You must determine from the documentation packaged with each program or interface the required format for the names, and how to assign them. As you determine the types of addresses to be used in the network, you must make sure that addresses are compatible between the communicating programs and interfaces:

- On the same LAN segment
- Across connected LAN segments
- Between LAN segments and other types of networks.

Programs and interfaces that involve host and controller communication, communication between LAN segments and other types of networks, and remote connections need careful consideration, so that the names and addresses assigned are compatible on the communicating networks or devices.

Communication between two application programs on a network occurs as follows:

- The sending application program prepares a message for the receiving application program, containing the receiver's name or address.
- The sender passes the message, usually through a support program or interface, to its adapter.
- The support program or interface and the adapter associate the receiver's name or address with the address of the receiver's adapter.
- The sender's adapter sends the message over the LAN segment or network to the receiver's adapter.
- The receiver's adapter and support programs or interfaces determine the receiving application program's name or address from the message.
- The receiver's adapter passes the message to the receiving application program.

The application program does not usually need to put adapter addresses in its messages. One of the functions of the support programs and interfaces is to associate an adapter address with a sending or receiving application program.

Network and Application Software

Many LAN administrative activities involve the programs, interfaces, and files used to accomplish the work done on the network.

Preparations for software installation include the following activities:

- Determine which application programs will run in each attaching device
- Determine which operating system, interfaces, and support programs are required for each attaching device
- Decide what programs and interfaces are needed to connect multiple LAN segments, or LAN segments to other types of networks
- Choose the values of parameters passed to the programs and interfaces to:
  - Select options or functions to be used
  - Allocate adapter, computer, and program resources
- Prepare copies of programs, interfaces, and files on working disks or diskettes
- Create procedures for accessing and using programs and data files
- Establish procedures for backup, recovery, and security of programs and data files
- Determine which programs provide the information required to isolate and resolve network hardware, software, and data transmission problems.

The remaining sections of this chapter further discuss some of these activities. Chapter 9 and Chapter 10 discuss the others in more detail.

Selecting Programs and Interfaces

You may obtain programs and interfaces written for IBM LANs from sales representatives and authorized dealers.

You may also choose to write your own programs and interfaces to perform similar functions, or to perform functions unique to the needs of your establishment. See "Writing Your Own Interfaces and Programs" on page 9-20, the *IBM Local Area Network Technical Reference*, the *IBM Token-Ring Network Architecture Reference*, and the *IBM PC Network Adapters Technical Reference* for more information about writing your own programs.

Interfaces and Support Programs

Application programs can be written to communicate directly with LAN adapters, with no intervening support. These application programs must:

- Manage their own data transmission protocols
- Control communication between the adapter, its device, and the LAN segment
- Detect and handle software, data, and hardware errors.

Most application programs that use IBM LANs require at least one intervening interface or support program, which relieves the application program of handling protocols, communication with the adapter shared RAM, interrupts, and some error conditions. Other application programs require additional interface support.

For workstations using DOS, the IBM Local Area Network Support Program provides basic adapter function support and NETBIOS interface support. OS/2 EE includes similar support for workstations. Operating system functions and other support programs (such as the IBM PC 3270 Emulation Program, the IBM PC LAN Program, the OS/2 LAN Server Program, APPC/PC, and the IBM Personal Communications/ 3270 Emulation Program) relieve application programs of additional network interface control functions.

For hosts and controllers, adapter and interface support can be included in host operating system functions, subsystem or control program functions, device or adapter microcode, and/or support programs.

Part 3 of this manual describes support programs and interfaces. The documentation packaged with each purchased application program should indicate the required interfaces and support programs.

Interconnection

Attaching devices and special programs can be combined to allow exchange of data between:

- Two LAN segments
- A LAN and another type of network
- Different types of devices.

The programs handle conversion of data transmissions from one protocol or format to another, and provide some status and error information for the networks and devices they connect. These connections may require corresponding programs in each communicating device to accomplish protocol conversion and data exchange.

Bridges

You can connect two LAN segments using one bridge or more than one bridge (*parallel* bridges). A bridge connecting two LAN segments can be formed by:

1. An IBM bridge program installed in an appropriate workstation with the appropriate two network adapters (local bridge function)

2. An IBM bridge program installed in two workstations using the remote bridge function. Each workstation is on a different LAN segment and each contains a network adapter and a communications adapter. A telecommunications link connects the two communications adapters.

3. An IBM 8209 LAN Bridge with an attachment module. One LAN segment connects to the attachment module, and the other LAN segment connects to a built-in connector in the base.

Chapter 15 describes IBM bridging products and their use in LANs.

Gateways, Servers, and Remote Connections
Combinations of programs and hardware can provide direct connections and remote connections between:

- Different types of devices on a LAN
- Devices on a LAN and devices on another type of network
- Devices on different LANS that communicate through another type of network.

For example:

- IBM Remote NETBIOS Access Facility Program provides NETBIOS equivalent connections between network workstations and workstations that are not directly connected to an IBM Token-Ring Network.

- The IBM PC 3270 Emulation Program (Version 3) provides local and remote gateway functions for communication between LAN users and users on WANs that use SNA.

- The Network Control Program (NCP) Token-Ring Interface (NTRI) can be used in IBM 3720, 3725, and 3745 Communications Controllers to connect an IBM Token-Ring Network to a System/370 or System/390 host.

- The IBM 3174 Establishment Controller and the IBM 9370 Information System also provide connection from an IBM LAN to a System/370 or System/390 host.

- The IBM 8232 LAN Channel Station provides a direct channel connection between a host and one or more LANs.

- The Advanced Program-to-Program Communication Program for the IBM Personal Computer (APPC/PC) allows application programs in workstations on a LAN to exchange data with each other, and with hosts running the Advanced Program-to-Program Communication Program (APPC).

- The IBM Asynchronous Communication Server Program and LANACS provide asynchronous communication server functions from IBM LANs to devices not directly connected to the network. Such devices may be physically too far away from the network to connect directly, or may use protocols not directly supported by the network but converted by the server.

- The IBM 3712 Interconnect Controller provides connection from several types of LANs to a System/370 or System/390 host. With appropriate adapters, the IBM 3172 can provide connection to Ethernet, MAP, IBM 4-Mbps Token-Ring Network, and IBM 16-Mbps Token-Ring Network.

- The IBM LAN to LAN Wide Area Network Program (LTLW) is a network communication program that enables IBM NETBIOS communication from one LAN to another over an existing wide area network (WAN). The LTLW communicates with LTLWs on other LANs over an SNA or X.25 network.

Some of these programs may require a corresponding program running in each communicating device. Some may also have specific addressing, naming, data format, or configuration parameter requirements that you must consider in the design of the network.

See Chapter 16 for descriptions of programs that provide gateway, server, and remote connections for IBM LANs.

Network Status and Problem Determination

On each LAN segment in the network, you should have available for use at all times a program that monitors LAN segment status and provides information needed for problem resolution. This may be a program written or obtained only for that purpose, or it may be one that serves other functions on the LAN segment as well.

The IBM Token-Ring Network problem determination procedures use the information supplied by the IBM Token-Ring Network Ring Diagnostic (or an equivalent). The IBM LAN Manager provides both information about the operation of the LAN segment and problem determination information. The IBM LAN Network Manager 1.0 provides information about the operation of the LAN, problem determination information, and information about resources such as bridges, IBM 8230 Controlled Access Units, and stations in the network. Some products that provide bridge and gateway functions also provide status about the LAN segments and networks that they connect.

See Chapter 10 for more information about managing LAN segment operation, and Chapter 11 for more about problem resolution. See "Writing Your Own Interfaces and Programs" on page 9-20 for more about writing your own programs.

Using the Network
The work to be accomplished on the network dictates the programs and interfaces needed on the network.

The choice of network and application software may affect the physical organization and layout of the network. These considerations should be discussed with the network planner as physical layout of the network is designed or modified (see "Planning the Network Layout" on page 8-6).

The documentation for each application program :

- Describes any additional programs or interfaces required for the application program
- Indicates which programs can share an attaching device on the network
- Lists the requirements for running the application program in the device (memory size, disk space, adapters, or type of device, for example)
- Describes the requirements for migrating from one version or release of a program to another.

Preparing Working Copies of Programs and Files

Purchased program products are usually supplied on diskettes or magnetic tapes and may be packaged with hardware, user's guides, or operator's guides.

To prevent damage to original diskettes, and to prepare the programs for operation, the programs are copied from the original diskettes to working diskettes or fixed-disk directories. DOS or another operating system may be required to create the working copies and to load the programs. Files that are needed to load the programs (or to provide parameters and options) are also copied to or created on the same working disk or diskette.

Programs and files supplied on tapes or other media are usually copied to disk storage on a computer system. The programs and files are generally used as input to a process (such as system generation, compilation, or linkage edit) that prepares programs to run on the computer system or in a device attaching to it.

If you write programs and interfaces for your network, you also need to copy them to the working disks or diskettes for the appropriate stations on the network. Label a master copy and store it so that it is protected from damage.

See Chapter 9 for more information on preparing working copies and files, filing and storing the original tapes and diskettes, choosing options and parameters, allocating resources, and writing your own programs and interfaces.

Software Access, Use, and Security

"Network Security" on page 10-6 describes some administrative activities involved with accessing, using, and securing your network programs and data files.

The planning phase of these activities is primarily:

- Deciding what levels and methods of security, backup, and recovery are required for each program, device, and file on the network
- Establishing procedures and instructions for accessing and using programs and files.

Network Change and Migration

You should consider and accommodate the future growth and changing objectives of the network in original network design and in daily operation.

Some considerations are:

- Leaving empty connection points in the hardware layout (putting in more than are immediately needed), to allow immediate connection of additional devices to the network, and to make problem determination procedures easier to accomplish.
- Deciding whether to split a large network now, or wait until the number of attaching devices reaches the allowed maximum (splitting may require installing a bridge between the LAN segments).
- Choosing attaching devices with more than enough internal memory and disk or diskette space now, or upgrading later.
- Anticipating future software needs for a greater or different workload on the network.
- Looking for software products to meet changing network objectives.

Because you monitor and manage the daily operation of the network, you can perhaps see more clearly than others the requirements for growth and the direction of change needed for future effective network operation.

Network Change
As the objectives and purpose of your network change, you will change the physical network layout, the software used to accomplish tasks on the network, and the hardware that connects to the network.

Such changes to an existing network require planning similar to that for a new network. In addition, care must be taken to preserve the normal operation of the parts of the network that are not changing.

Keep in mind that:

- Adding, removing, or replacing devices or components may then require changes in programs, system parameters, or configuration parameters.
- Adding, removing, or changing application programs may also require changes in required devices, adapters, other network components, support programs, interfaces, or protocols.
- Hardware or software changes may affect the functioning of remote connections to devices that are not directly connected to the network.

As you change your network, you must also update your network charts and floor plans to reflect the changes. This is particularly important for problem determination and resolution once the changes have been made in the network.

Migration in the Network

Often the changes you make in your network involve updating to new levels, versions, or models of the products used in the network.

New models of devices or network components usually have new features or enhancements to existing features. The hardware enhancements sometimes require new versions of support programs, or may require changes in system or application configuration parameters.

Similarly, new levels and versions of programs may require certain devices, may no longer support older devices, and may require configuration parameter changes or file reformatting.

The publications packaged with the products describe their requirements for installation and operation. Product descriptions available from suppliers and on product packages also summarize the requirements.

Some products provide conversion and migration aids to help you move from one level or version to the next. Most contain descriptions of the actions that must be taken to replace program, configuration, system, and, and data files.

As you make changes in your network, you also need to:

- Review and update files of master and backup diskettes
- Update user instructions, passwords, network access procedures, and perhaps problem resolution procedures
- Keep new product licenses, warranties, and service agreements in a safe and accessible place.

Chapter 9. Hardware and Software Installation

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Hardware Installation

As your network is planned and designed, you and the network planner work together to prepare materials needed for installation of network components. When hardware installation is complete, you will need to verify the operation of the network.

You and others in your establishment can install small IBM PC Networks and most IBM Token-Ring Networks. IBM PC Networks connecting more than 70 or 80 devices usually require the services of a professional network designer/installer.

Most of the discussions in this manual assume that cabling for your establishment has already been planned and installed. However, you may be asked to take part in those activities also.

Providing Charts and Labels

At hardware installation time, you or the network planner need to provide to the installer copies of the charts completed during the planning of the network. The installer needs:

- Cabling and sequence charts to show how to connect cables, devices and hardware components together to form the LAN segments
- Bridge Planning Charts to show how to connect LAN segments together
- Other documents to show how to make connections from gateways and communication servers to remote devices and to devices on other networks.

During network planning, you and the network planner:

- Chose a numbering and labeling scheme for the components and cable connections in your network
- Prepared adhesive labels to affix to network components and cable connections during installation.

You will need to give the installer the prepared adhesive labels. If the labeling scheme you chose is different from the one described in network and IBM Cabling System documents, you will need to explain the scheme to the installers so they can understand and use the planning charts and labels.

Installing Network Adapters in Attaching Devices

Each device that connects directly to a LAN must have at least one network adapter or attachment feature installed in it.

As described in "Network Adapters and Attachment Features" on page 1-10, your preparation to install network adapters includes:

- Determining the adapter addressing requirements
- Assigning addresses, if necessary
- Determining the values or settings for adapter hardware and software configuration parameters.

Installing Network Adapters in Workstations That Use PC/IO Channel Architecture

Installation of a network adapter in a workstation that uses PC/IO Channel architecture includes the following steps:

1 Set the switches or jumpers on the adapter to the values you selected for the adapter hardware configuration options or parameters.

2 Record the parameter settings in the network documentation.

You can record the settings in the adapter document or in another place you designate in the network documentation. This enables you to see what the settings are without removing the adapter from the workstation or running adapter diagnostics.

3 Follow the instructions packaged with the adapter to install each adapter in its attaching device.

4 After the adapter is installed, run the Adapter Diagnostics or Advanced Diagnostics to:

- Verify that the adapter is operating normally
- Verify that the adapter parameters were set correctly
- Determine the universally administered adapter address, and record it in the network documentation.

5 Connect a cable to the adapter.

6 Connect the adapter cable to a network connection point or access unit.

Notes:

1. The universally administered adapter address for a network adapter is **NOT** the serial number of the adapter card, which is engraved on its surface. You can determine the universally administered adapter address for each adapter only by displaying it with the diagnostics (or another program that displays adapter addresses).
2. You may want to write the universally administered address on a label, and affix the label to the attaching device. This can help you identify the adapter during network modification and problem determination without running the adapter diagnostics again.

Installing Network Adapters in Workstations That Use Micro Channel Architecture

Installation of a network adapter in a workstation that uses Micro Channel architecture includes the following steps:

1. Follow the directions packaged with the adapter and in the workstation's *Quick Reference* manual to:
   - Install the adapter in the attaching workstation
   - Update the workstation's Reference Diskette with the modules from the adapter Option Diskette (for IBM Token-Ring Network adapters only).
2. Use the workstation's Reference Diskette configuration function to verify and, if necessary, change the adapter configuration parameters.
3. Run the system tests on the Reference Diskette or run the Advanced Diagnostics to:
   - Verify that the adapter is operating normally
   - Verify that the adapter configuration parameters were set correctly
   - Determine the universally administered adapter address; record it in the network documentation.
4. Connect a cable to the adapter.
5. Connect the adapter cable to a network connection point or access unit.

Notes:

1. The universally administered adapter address for a network adapter is **NOT** the serial number of the adapter card, which is engraved on its surface. You can determine the universally administered adapter address for each adapter only by displaying it with the system tests or diagnostics (or another program that displays adapter addresses).
2. You may want to write the universally administered address on a label, and affix the label to the attaching device. This can help you identify the adapter during network modification and problem determination without running the adapter diagnostics again.

Installing Host and Controller Network Adapters and Features

Hosts and controllers may access a LAN in one of two ways:

- Direct connection to the LAN by a network adapter (or attachment feature) installed in the host or controller.

  The adapter may be installed as the device is manufactured, or may be installed by the user.

- Connection to a workstation that is connected to the LAN.

  The workstation and the host or controller require an appropriate connection through adapters or attachment features. The workstation requires an appropriate network adapter.

To connect a host or controller directly to a LAN, refer to the publications packaged with or related to the host or controller to determine the necessity for and sequence of doing the following:

- Setting hardware options or configuration parameters
- Installing the adapter or feature in the attaching device
- Setting software configuration parameters
- Verifying that the adapter or feature is operating correctly
- Determining and assigning required addresses
- Connecting a cable from the adapter or feature to the LAN
- Recording information about the adapter or feature in the network documentation.

To connect a host or controller to a LAN through a directly connected workstation, refer to the publications packaged with or related to the host or controller to determine the necessity for and sequence of doing the following:

- Setting hardware options or configuration parameters
- Installing the adapters or features in both devices
- Setting software configuration parameters
- Verifying that the adapters or features are operating correctly
- Determining and assigning required addresses
- Connecting a cable from the workstation to the host or controller, and a cable from the workstation to the LAN
- Recording information about the adapters or features in the network documentation.

Setting parameters and verifying the normal operation of adapters and features installed in hosts and controllers may require preparation and use of operating systems, subsystems, control programs, microcode, and other support programs that run in each device.

Verifying Cable Connections

In addition to installing network adapters in stations and connecting adapter cables to network connection points, the installer must connect cables between access units, conversion and regeneration units, and other connection hardware to complete the network.

When network hardware installation is complete, the network administrator or planner should verify that the cable connections and the network layout charts are complete, correct, and in agreement. This means examining each connection point or access unit and newly connected device on each LAN segment in the network, checking each connection to see that:

- Cables and power cords are physically connected correctly
- Labels contain the correct information and are placed at the correct connection
- Network layout charts are completed correctly and agree with the physical connections.

You will need to work with the network planner and the installer to correct any discrepancies found during the verification.

Verifying Network Operation

After installation is complete and the cable connections are verified, the next task is to check out the operation of the network.

To verify operation of each LAN segment:

1. Select a few workstations connected to the LAN segment.
   - On an IBM Token-Ring Network, select one device connected to each IBM 8228 or IBM 8230 in the LAN segment.
   - On an IBM PC Network, select a few workstations at various connection points on the LAN segment.
2. Run an application program in each selected device to see that data can be transmitted over the LAN segment. (See "Programs for Verification" on page 9-8.)
3. Resolve any problems. (See "Resolving Problems" on page 9-9.)
4. Connect the rest of the devices to the LAN segment.

To verify the operation of networks containing bridging products, gateways, and remote connections:

1. Verify that each LAN segment, remote device, and all networks operate normally.
2. Connect to each LAN the devices providing bridge, gateway, and remote connections.
3. Connect remote devices to servers, gateways, public switched network connections, or other communication equipment.
4. Use application programs or diagnostic tests to verify that devices can communicate across the connecting devices. (See "Programs for Verification" on page 9-8.)

   The publications packaged with and relating to devices and programs providing the connection functions may contain specific procedures for verifying the connections.
5. Resolve any problems. (See "Resolving Problems" on page 9-9.)

Programs for Verification

For the verification, you will need to choose or write application programs that indicate to you that they are sending and receiving data correctly on a LAN segment or network. For example, you might use programs that generate and acknowledge test traffic, send print files, or send messages that are displayed at another device.

You may want to prepare a working diskette or file containing such programs to use just for installations or problem determination. You could then load the programs on the devices in your network as the need arises for verification of problem resolutions or network changes.

For workstations, you can use the IBM PC LAN Program (with the IBM LAN Support Program) to create such a working diskette for both the IBM Token-Ring Network and the IBM PC Network. You can use the IBM PC LAN Program to send messages between stations and to send small print and data files to a server.

The *IBM Token-Ring Network Starter Kit Guide* [1] contains an Installation Aid and instructions for creating such a test or demonstration diskette, using the IBM PC LAN Program to send messages between stations.

The Advanced Diagnostics packaged with the *IBM PC Network Hardware Maintenance and Service* manual contain a Transmit/Receive Verification Test. The test is used to verify that two stations on a LAN segment can communicate.

Some network application programs provide functions that can help you verify the operation of LAN segments and networks:

- The IBM LAN Network Manager includes a Test Segment function that allows you to verify that the LAN Network Manager's adapter can communicate over its segment. If there are IBM 8230s in the network, LAN Network Manager can display the wrap state of a particular IBM 8230.
- The IBM LAN Manager contains two functions:

  For the IBM Token-Ring Network only, the **Path Test** verifies that two workstation adapters on the same or different LAN segments (between which there are no more than seven bridges) can exchange data.

  For both the IBM Token-Ring Network and the IBM PC Network, the **LAN Segment Test** verifies that a specified LAN segment can transfer data. The test indicates the possible source of the problem in the event that the test fails.
- Most IBM bridging products include a **Bridge Test** to verify that the bridge program can communicate from each LAN segment through the bridge to the other LAN segment.

Refer to the publications for the devices and products using the network for more information about verifying normal product and network operation.

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[1] The *IBM Token-Ring Network Starter Kit Guide* is no longer available from IBM.

Resolving Problems
For the **IBM Token-Ring Network**, the procedures in the *IBM Token-Ring Network Installation Guide* contain instructions for resolving any problems you find during verification of a newly installed network.

If using the installation procedures does not resolve a problem, you are instructed to refer to the procedures in the *IBM Token-Ring Network Problem Determination Guide* to isolate failing network hardware components. You may need to provide spare cables, adapters, repeaters, and access units to use in checking for and resolving problems.

Once the network is verified to be operating correctly, each attaching device can be brought into operation.

For the **IBM PC Network**, you need to put procedures in place for identifying, isolating, and resolving any problems you find during verification of a newly installed network. Your procedures can include:

- Using adapter Advanced Diagnostics, power-on self-tests (POSTs), and IBM Personal System/2 system tests to verify operation of network adapters and other hardware components
- Using the Advanced Diagnostics Transmit/Receive Verification Test to verify communication between stations on a LAN segment
- Following recommended problem resolution actions for error codes displayed by application and support programs, POST, and diagnostics
- Isolating the failing component by swapping components that appear to be malfunctioning with spares or other components that have been verified as operating correctly.

If your network is being installed by a professional network designer/installer, the professional will usually verify the operation of the network during installation. You can obtain an agreement with the professional designer/installer or a service supplier for assistance in putting your procedures in place for problem resolution after the network is installed. The agreement will probably include problem resolution assistance from your professional network designer/installer in the event that your establishment procedures do not resolve the problem.

You may need to provide spare cables, adapters, and other hardware components to use in checking for and resolving problems.

Once the network is verified to be operating correctly, each attaching device can be brought into operation.

Network Modifications
When modifying or repairing an existing network, you will need similar procedures for attaching new or repaired devices to the network, and for determining that they are operating correctly. The procedures you use for initial network installation can be used as guidelines and for reference.

Software Installation

Most stations connected to a LAN run programs used to accomplish a specific task. (Some controllers, such as the IBM 3174, have only microcode and do not support user-loaded programs.) Most stations require more than one program running at the same time to accomplish a task.

In planning the network for your establishment, you selected for each attaching device:

- One or more application programs to use for the task to be accomplished
- The operating system required by the device, at the version required by the programs that run in the device
- One or more programs that provide the protocol, interface, adapter, and network communication support needed for the application programs.

Using the software on the network usually requires some preparation. Such preparation can include:

- Formatting a fixed disk file or directory or a diskette so that it can contain the programs and files for the device. The operating system in the device, or in the host to which the device is connected, usually provides the functions required to format disks and diskettes.
- Copying the selected combination of programs onto the formatted disk or diskette in the format and sequence required by the device and the operating system.

  The programs come in separate packages, usually including some documentation and sometimes accompanying related hardware items (such as network adapters). Programs used in network workstations are usually supplied on diskettes; host and controller programs are usually supplied on magnetic tapes.
- Creating and/or modifying files to provide information to the programs at load time and during execution.

  Such information can include load and configuration parameters, program load commands and sequences, device or feature characteristics, and data to be processed or analyzed.

"Preparing Programs for Workstations" on page 9-11 and "Preparing Programs for Devices Other Than Workstations" on page 9-19 describe activities included in preparing software for installation and operation on your network.

Preparing Programs for Workstations

Make working copies of the programs and files supplied on diskettes:

- To prevent the original diskettes from being damaged in repeated use.
- To place together in the right order and format all the programs, interfaces, and files required at one time to run one or more application programs in a device.
- Because the original diskettes are often write-protected. Load files, configuration files, parameter files, and data files cannot be created or modified on the original diskette.

Preparing Working Disks or Diskettes

Before preparing a fixed disk or diskette for a workstation, you need to decide:

- Whether the programs and files will reside on fixed disk directories or on diskettes
- Which programs and files need to be on the same fixed disk directory or diskette
- How programs will be loaded into the computer memory
  - By typing an operating system load command for each program
  - By typing the name of a command or batch load file that the operating system will use to load more than one program at a time
  - By having the operating system automatically read a command file or batch load file when the computer power is turned on or when a system reset key sequence is pressed
- What load and/or configuration parameter values to specify for each program.

When the decisions have been made, obtain:

- The operating system at the correct version required by the workstation and the programs that run in the workstation (DOS or OS/2 for most IBM workstations)
- The original diskettes containing interfaces, application programs, files, and diagnostics
- Enough blank diskettes to contain the copies and backups, and/or access to the fixed disks that will be used
- The documentation for the adapters, programs, and the operating system.

Then, prepare each working disk or diskette according to the instructions packaged with the selected programs. The preparation instructions usually include these steps:

1. Format blank diskettes and create or modify fixed disk directories and subdirectories to contain the copied programs.

   Some programs require the operating system to be on the same diskette with the programs. If so, the operating system is usually copied to the diskette during formatting.

   The operating system is usually in the root or main directory on a fixed disk. The load command (typed or in a command or batch load file) for a program specifies the directory or subdirectory that contains the program if it is not in the same directory as the operating system.

2 Copy programs and files to the working diskettes or fixed disks from the original program diskettes (or backup copies of the originals).

3 Change or create files to:

- Specify required system configuration commands and parameters
- Specify program load and configuration parameters
- Load more than one program at once (using a command or batch load file).

4 Make the required number of copies of each working diskette. Label working diskette copies with:

- Program names, and levels or versions
- Date copy was made
- User and/or device using the diskette
- Any other information pertinent to your establishment.

5 Back up the contents of fixed disks onto diskettes or magnetic tapes.

6 File and store original diskettes, fixed disk backups, and masters of the working diskettes in a safe place.

The Operating System

Most IBM program products that run in workstations require some level or version of an operating system to copy, edit, or load programs and files.

Refer to the documentation packaged with the operating system for instructions on how to use its copy, edit, and load functions.

Operating System Included with the Program Product

Some programs (such as the Adapter Diagnostics and the Advanced Diagnostics) are designed:

- To be loaded automatically by turning the computer power on or pressing the system reset key sequence (CTRL-ALT-DEL)
- To run stand-alone in the computer, with no other programs running at the same time
- To be run from a diskette, and usually not from a fixed disk.

An operating system file is supplied on the diskette with these programs. The file contains the required level and functions of the operating system for running the programs, and is copied to the working diskette as the programs are copied. (A separate copy of the operating system must be running in the computer in order to copy the programs.)

You Provide the Operating System

Most application program products do not include the required level of the operating system as part of the package. You must obtain a specific minimum level of the operating system and use it to:

- Format working diskettes
- Create entries in fixed disk directories
- Load and support application programs. (The operating system must first be loaded from its own working copy or from a file you copy onto the application program working disk or diskette.)

System Files and Parameters

To support application programs, including those for LANs, the operating system may require that some system files be present on the working disk or diskette.

Such files describe to the operating system:

- The number of disk buffers available
- Which device drivers are being used
- The number of files that can be open at one time
- The maximum drive letter you may access
- The name of a top-level command processor.

Some of the configuration command parameters indicate the presence of other operating system files that may be needed to run your application programs. For example, if a program uses device drivers to extend keyboard and control functions, you will need a file called ANSI.SYS on your disk or diskette (this may be used for device emulation or to indicate the language in which application program messages are displayed).

The CONFIG.SYS file must be stored on the diskette or in the root directory of the disk used to start the computer. Changes to the file do not take effect until the computer is restarted and the operating system is reloaded.

The documentation packaged with each program product should indicate the required operating system configuration parameters, parameter values, and additional files. The *DOS Reference* manual and the *Operating System/2 User's Reference* manual explain how to create or modify the CONFIG.SYS file and how to specify the configuration commands in the file. The *Disk Operating System Technical Reference* and the *Operating System/2 Technical Reference* discuss operating system functions (such as enhanced device drivers and extended keyboard and control functions).

Some Decisions

Before making the working copies, you need to decide:

- How programs will be loaded
- What programs and files go on which disk or diskette
- What values to specify for load and configuration parameters.

Loading Programs

The operating system must be loaded and running in a workstation before application programs can be loaded and used on the network. Application programs can be loaded:

Manually. At the operating system prompt, the workstation operator can type a *load command* (usually the name of the program) to load one program from a working disk or diskette. A command must be typed for each program to be loaded.

Using a command or batch load file. You can create a *command file* (OS/2) or a *batch load file* (DOS) on the working disk or diskette. The file will contain load commands for one or more programs. When the operator types the name of the file, the operating system reads the file and loads each program whose name (or load command) is in the file.

Automatically. The working disk or diskette is formatted to also contain the operating system, so that the operating system loads automatically when the computer power is turned on or the system reset key sequence is pressed. The operating system then reads a special command file (OSINIT.CMD for OS/2) or batch load file (AUTOEXEC.BAT for DOS) from the working disk or diskette. Then each program whose name (load command) appears in the file, automatically loads and runs in the computer.

Disk or Diskette Contents

For the application programs that run in each device on your network, determine which programs and files must be on the same disk directory or diskette at the same time:

- The programs and files supplied on an original diskette may get copied to different disk directories or diskettes in preparing the working copies.
- Programs from several original diskettes may get copied to the same working diskette or disk directory.

You may need to create or obtain additional files or programs besides those on the original diskettes, in order to run application programs.

If you are running more than one application program on a device, be sure there is enough room on one working disk directory or diskette for all of the required programs and files, or determine how to spread the programs and files over more than one disk directory or diskette. Remember to include space, if required, for data files that may grow in size as they are used by the application programs.

The documentation packaged with the programs should describe what programs and files must be on the same working disk directory or diskette. A list of the files on each original diskette may be provided; the list may also show the size in bytes of each file. If the list is not provided, you can use an operating system command to list the directory on each original diskette and display the file names and sizes.

Load and Configuration Parameters
Some programs allow or require the passing of parameter values to them as they are loaded into a device. These parameters can:

- Allow or inhibit the operation of certain program functions or features when the programs are running
- Specify values for allocating resources used by the programs, the device, and the adapters (timers, data buffers, and control blocks, for example).

For some programs, the load command for each program specifies the parameters, along with the program's name. For other programs, you will need to create or modify separate parameter or configuration files that are read when the programs are loaded.

Most parameters default to a particular value if a value is not specified on a load command or in a configuration file. For each parameter, you need to decide:

- Whether to use the default value
- What the value should be if the default is not used.

See "Load and Configuration Parameters" on page 9-16 for more about parameters and configuration files.

Making the Copies

Once you obtain the required level of the operating system and make the decisions concerning disk or diskette contents and program parameters, then use the operating system to:

- Format blank diskettes for working copies that will reside on diskettes
- Prepare fixed disk root directories and subdirectories to contain the required entries for working copies that will reside on fixed disks.

When the diskettes and directories are prepared, use the operating system to copy the programs and files from the original diskettes to the appropriate diskettes or fixed disk directories.

Refer to the documentation packaged with each program for specific instructions about the format required for diskettes, and about the entries required in fixed disk directories for each program. Refer to the following manuals for instructions on formatting disks and diskettes and on copying programs and files:

- *IBM PC DOS User's Guide*
- *IBM PC DOS Reference*
- *IBM Operating System/2 User's Guide*
- *IBM Operating System/2 User's Reference.*

Notes:

1. After preparing a working diskette, including creating or modifying any required files, you may want to keep a master copy of the working diskette.

2. You may want to back up working disk directories onto magnetic tape or diskettes.

   These masters can be copied to replace working diskettes and directories without having to recreate the contents from the original diskettes and without having to create or modify files again.

Creating and Changing Files

Once the programs and files are copied from the original diskettes, you may need to change some of the files or create additional files. The changed or new files may be batch load files, configuration files, or data files.

You can use the EDLIN editor provided with DOS or OS/2, or another editor or text processing program (such as the IBM Personal Editor or the IBM Professional Editor*) to change these files. The editor used must preserve the format of the files, and not insert characters in the files that are considered invalid by DOS or OS/2.

Some application and support programs provide configuration or installation aids. These aids use panels or menus to help you change or create certain required files.

Load and Configuration Parameters

Parameters are used to pass information to a program as it is loaded into computer memory to be run. The program uses the parameter information to:

- Allow or inhibit the operation of certain functions or features when the program is running (such as logging or tracing)

- Allocate program, device, and adapter resources that can vary in size, number or duration (timers, buffers, service access points [SAPs], and control blocks, for example)

- Make a choice (for example, use adapter 0 or adapter 1; use a certain memory address for buffers or control blocks).

Note: Specifying appropriate values for parameters is crucial to the optimal operation of your network and its application programs.

Load Command Parameters
For some programs, parameters are specified as part of the command used to load the program. The load command is either typed by an operator to load one program, or placed in a batch load file with other commands. The load command is usually in the format:

progname parm1,parm2,...,parm n

The documentation packaged with each program should describe the format and valid values for any parameters that can be specified on the load command for the program.

Parameter or Configuration Files
The parameters for some programs are specified in a separate file on the working disk or diskette. During the loading of the program, the file is read and the program processes the parameters from the file.

Products that use separate parameter or configuration files are usually packaged with one or more of the following:

- Instructions for creating the required file
- A default or initial file that you modify to use parameter values other than the defaults
- A program that helps you create or modify the required file (by making selections or filling in fields on menus or panels)
- Descriptions of parameter formats and valid values.

Many programs that run on LANs use configuration or parameter files to specify features, functions, or data transmission characteristics, including:

- Load/do not load code modules to provide certain features or functions
- Allow/inhibit operation of certain features or functions
- Adapter number (0 and/or 1) used by the program or interface
- Addresses and names by which the adapter is known to the program or interface and to those programs or interfaces with which it communicates
- LAN segment number, bridge number
- Ranges and maximums for numbers and sizes of resources, transmissions, and control mechanisms, including
  - Request/response units (RUs) or frames
  - Buffers
  - Active sessions
  - Pacing windows
  - Link stations
  - Storage and work space
  - Conversation duration
- Broadcast and datagram transmissions
- Dump and/or restart on program error
- Machine type, model, and serial number of the attaching device
- Translation tables for character set conversion

- System recognition of device features or functions (for example, DOS Control Break)
- Error and traffic counters, statistics, thresholds, and tolerances
- Timer and time-out values
- Logging (errors, traces, events, traffic), log buffers, and log retrieval.

The parameters contained in these configuration files are critical to the operation of the network and its application programs. Incorrect settings of the parameters may cause network error conditions, and data retransmissions due to buffer overruns or processing overloads. Should soft errors, data retransmissions, and buffer overruns occur on the network, check the values of these parameters for possible errors and adjust the values as necessary. Typical error conditions might include:

- Too few or too small buffers at the receiving station; frequent buffer overruns and data retransmissions are occurring
- Different maximum message sizes at sender and receiver, and the application programs do not negotiate to the smaller size before transmission; may necessitate message segmentation and data retransmission
- Incorrect specification of pacing or other flow control parameters; programs cannot process information as fast as it is received.

Loading and Ending Programs and Files

Once working disks and diskettes are ready, programs and interfaces can be loaded to begin operating and doing work on the network.

Some application programs provide specific actions, commands, or procedures to end their operation and return to DOS or OS/2 without pressing the system reset key sequence. This allows you to load another application program without first loading DOS or OS/2 again.

Make sure the operator or user of each attaching device has the appropriate working copies, and has instructions for loading, using, and ending each application program. The instructions should include how and when to:

- Load specific programs
- Access systems and application programs
- Obtain, use, and change any required passwords
- Report and/or resolve problems
- Terminate, unload, or shut down each application program
- Make backup copies of files
- Obtain replacement working copies, if necessary.

See "User Education, Procedures, and Assistance" on page 10-3 for more on instructions and assistance for users and operators. The documentation packaged with each program should describe the procedures, commands, and actions necessary to load, use, and end the program.

Preparing Programs for Devices Other Than Workstations

Some devices that connect to or communicate on IBM LANs are not workstations. Many of these devices are other small computer systems, or devices that connect an IBM LAN to other computer systems (the IBM 9370 Information System, the IBM 3720, 3725 or 3745 Communications Controller, the IBM 3174 Establishment Controller, the IBM 3172 Interconnect Controller, the IBM System/36 or 38, the IBM AS/400, and the IBM Series/1, for example).

The programs and files for these products are usually supplied on some form of magnetic tape, instead of on diskettes.

Preparation of these programs for use is done either in the connecting small computer system, or in the larger computer system to which the device is connected. The preparation usually requires one or more of the following steps:

To prepare programs for hosts and controllers:

1. Copy programs and files from magnetic tape to files or libraries on disks.
2. Prepare code statements or commands as input to a generation, a compile, an assembly, a linkedit, or other program preparation process.
3. Start the preparation process, which will:
   - Use the input commands or code statements, and any required files from the magnetic tape (either still on the tape or copied to disks).
   - Convert a program to, or produce a program in, a format that will run in the connecting device.
4. Install, activate, and/or run the program in the connecting device.

The code statements and commands define addresses, symbolic names, parameters, and options that allocate resources and enable communication to be established between each device or network.

Running these programs on a LAN may require some operator action at the connecting device (such as entering commands or pressing keys) to establish the connection.

Communication may also require complementary programs on each network or in each device. For example, transaction programs written using the LU 6.2 interface and supported by APPC/PC may require a version of APPC to be active in each communicating device. All complementary programs and the application programs requiring them must be prepared and active before communication can be established.

Writing Your Own Interfaces and Programs

IBM Personal Computers, Industrial Computers, and Personal System/2 computers are some of the devices that connect to IBM LANs. This section discusses writing your own application programs for use with such workstations. Similar considerations apply to writing programs for other types of devices that attach to LANs.

When writing your own application programs, you need to consider:

- Whether your application program will use an available software interface and/or support program to simplify communication with the adapter and the LAN
- Whether to write your own interface and/or support program
- How much and what type of communication your application program will have with the user or operator
- How your application program will participate in allocation of resources (buffers, SAPs, link stations, timers, and message sizes, for example)
- How your application program will interact with adapter and computer features and functions.

Workstation Program Features, Functions, and Parameters

When writing programs, you may want to include code that allows you to:

- Obtain information about the operating status of a program
- Use adapter addresses other than the universally administered address
- Vary allocation of adapter, computer, and application resources (to control program data transmission and processing, perhaps)
- Obtain LAN segment and error status.

Appendages

User-supplied appendages provide exit points from the adapter support portion of the IBM LAN Support Program to the application program. These appendages are short subroutines that may improve the application program's ability to handle information or events.

The types of user appendages are:

- Command completion appendage
- Data received appendage
- Exception conditions
- PC-Detected error appendage
- LAN segment status appendage
- Adapter check appendage
- DLC status appendage.

User-written programs may use appendages to handle error conditions or to gather statistics or operating status. Status and condition codes or indicators can be displayed or logged by your programs, providing you with information to monitor the operation of the program and to resolve any problems that occur.

The *IBM Local Area Network Technical Reference* contains guidelines for using appendages along with the status and codes that can be obtained.

Addressing

Application programs, support programs, and interfaces identify each other by means of names or addresses. These names are NOT usually the adapter address of the device in which the program or interface is running.

Support programs and interfaces participate in the process of associating an application program name with an adapter address, in order to send a message from one application program to another on the network.

When writing your own programs and interfaces, make sure that each handles the appropriate level and type of addressing. See "Network Addressing" on page 2-16 for more about assigning addresses and names in your network. See the *IBM Token-Ring Network Architecture Reference* for uses and restrictions for the different types of adapter addresses.

Parameters and Resource Allocation

Your user-written programs and interfaces must be able to handle network, computer, and application program resource allocation and function selection as appropriate. Parameters that can be varied at load time and/or during execution of the programs allow you to achieve optimal operation of the programs and the network.

Buffers, SAPs, and Link Stations
With the exception of moving data to and from computer memory, the adapter handles the LLC sublayer of DLC. The application program defines items for the adapter, such as SAPs and link stations used to establish and conduct communication between application programs in the same or different devices on the network.

Once an application program has set up and opened links, its adapter monitors, directs, and provides necessary fields for transmit and receive communication. The adapter maintains control information about each SAP and link station.

The DLC interface supports link-connection-type communication and ensures link connection before permitting the transmission and following the receipt of information frames.

When an adapter is opened, buffers are prepared in shared RAM for use in receiving and transmitting data. Buffer space exists in shared RAM, and in the application program area of computer memory.

The adapter transmits to the LAN segment from buffer space in shared RAM. Likewise, the adapter receives data from the LAN segment and places it in the adapter's shared RAM. The adapter support function of the IBM LAN Support Program, moves data to and from adapter shared RAM and the application program's computer memory buffers. When the IBM LAN Support Program is used, the application program must provide the buffer space in the application program area of computer memory. Control of these buffers may be maintained by the LAN Support Program or the application program as determined by the application program.

Buffer pools can be allocated for every SAP defined to the adapter and for the direct interface direct station. The application program may allow the LAN Support Program to prepare and control the buffer pools, or it may take that responsibility itself.

Your application programs must provide the means to create the appropriate number of SAPs and link stations, and to allocate and control buffers for application program data transmission and receipt.

The *IBM Token-Ring Network Architecture Reference*, the *IBM Local Area Network Technical Reference*, and the *IBM PC Network Adapters Technical Reference* describe how to provide and control buffers, SAPs, and link stations.

Programs That Provide LAN Segment Status and Error Information

The IBM LAN adapters and software interfaces are designed to collect and provide information about network components and events. The information includes:

- Command completion
- Data receipt, transmission, and processing
- Error and exception conditions (hardware and software)
- LAN segment status
- DLC status
- Adapter status.

Application programs written to run on a LAN use commands and control blocks to obtain such information. The information can be used by the application program to handle internal processing more effectively, and to notify a user of network status and error conditions.

The IBM Token-Ring Network Ring Diagnostic and IBM LAN Manager obtain and display information about a LAN segment to help you isolate and resolve error conditions on the LAN. The information they provide includes:

- LAN segment status (normal, beaconing, soft error, adapter closed, wire fault, no carrier, and continuous carrier)
- Adapter addresses for one or two adapters identified as involved in an error condition
- Reason or return codes and other data associated with the error condition
- Status of the adapter used to run the Ring Diagnostic or IBM LAN Manager
- Status of the program itself.

You may want to write your own application program to use instead of, or in addition to, the Ring Diagnostic or the IBM LAN Manager to obtain LAN segment status and error information. To be used effectively with IBM Token-Ring Network problem determination procedures, your program should obtain and display at least the types of information provided by the Ring Diagnostic (as listed above and discussed in the *IBM Token-Ring Network Problem Determination Guide*).

The *IBM Local Area Network Technical Reference* contains:

- Details about the contents and formats of the commands and control blocks used by application programs to obtain LAN segment status and error information
- Descriptions of additional information that can be obtained, such as logs, counters, and traces.

"LAN Segment Status and Error Information" on page 11-16 discusses the use of LAN segment status and error information in network problem resolution. "The IBM Token-Ring Network Ring Diagnostic" on page 13-3 describes the Ring Diagnostic, "The IBM LAN Manager Version 2.0" on page 14-8 describes the IBM LAN Manager functions, in obtaining error and status information, "The IBM LAN Network Manager Version 1.0" on page 14-13 describes the IBM LAN Network Manager 1.0 functions.

User-Written Programs for Use with LAN Products

Some program products used on LANs need additional user-written programs to:

- Provide application program products with function that is dependent on network configuration or establishment requirements
- Collect, analyze, present, or otherwise manipulate data files produced or provided by the program product
- Transfer data from one part of the network to another
- Manage, monitor, or present information about network traffic flow or utilization.

The publications packaged with the program products should describe the programs that the user must or can provide.

Chapter 10. Administration of Daily Network Operation

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User Education, Procedures, and Assistance

Users of the network may include workstation users, operators, programmers, administrators, and persons doing problem analysis. All of these users will need some instructions in using the network to accomplish their assigned tasks. The instructions can be provided through:

- Classes, tutorials, and demonstrations
- On-the-job or hands-on training
- Written procedures, manuals, and other documentation
- "Help Desk" and other methods of user assistance.

Classes, Tutorials, and Demonstrations

You may want to conduct or arrange for formal instruction in the use of some of the network equipment and programs. This can be done through classes taught by someone in your establishment or by IBM and other suppliers or manufacturers of the equipment or programs.

Some products provide tutorials that each user can run and view at a device. You may provide a copy to each user, or arrange for each user to view the tutorial at an appointed time.

It may be beneficial to demonstrate the use of a product to some users before they actually try to use it. The demonstration might include:

- Normal use of the product
- How to use Help panels or other explanatory material provided with the product
- Procedures that the user may refer to after the demonstration
- What to do when there is a problem during use of the product.

On-the-Job or Hands-On Training

Some users (operators, for example) may require training while they are actually using the programs or equipment in the network. These users may be responsible for such activities as maintaining the operation of the network or resolving network problems. Some of their training may not be possible until the network is installed and operational; they may even participate in installing the network and bringing it into operation. They may also require special procedures for their activities (such as backup and recovery, problem resolution, and modification of network configuration or operating parameters).

Procedures and Instructions

In addition to classes, tutorials, and training, users of the network will need some instructions that they can refer to as needed. These instructions will probably be in a written form, and will probably contain different information for the various tasks or uses of the network.

These instructions can explain how to:

- Use various devices and equipment
- Load, access, and terminate application programs (including use of passwords and logon information)

- Use the OS/2 EE interface for application programs operating under OS/2 EE (see "OS/2 Interface" on page 10-4)
- Use special key functions for each application program (see "Special Key Functions" on page 10-5)
- Obtain assistance with questions and problems (see "User Assistance" on page 10-5)
- Report problems, and what information to provide when reporting problems
- Obtain replacement working copies of programs, files, and diskettes
- Obtain and use network and program documentation (include a list and location of documentation)
- Perform backup, recovery, and problem determination procedures, for users authorized to do so
- Obtain LAN segment status and error information
- Change system and configuration files, for users authorized to do so
- Obtain spare components and supplies (diskettes, paper and ribbons for printers, blank adhesive labels, and so on).

You will need to establish a method of distributing these instructions, and for updating and replacing them as needed.

OS/2 Interface

Some network application programs, such as the IBM LAN Network Manager, run under OS/2 EE. The user must know how to use the OS/2 interface in order to use these application programs.

The OS/2 documentation (see "Related Publications") describes the OS/2 screen interface, which is the set of windows, menus, panels, and pull-downs that is displayed on the screen and used to perform program instructions. This description includes instructions for maximizing and minimizing windows, using the icons, or symbols, at the bottom of the screen that represent programs running in windows that have been minimized, and selecting functions using the mouse or the keyboard. You may want to provide to your users a summary chart similar the example in Figure 10-1 that shows the different methods users may choose to select a menu item or an action bar choice.

OS/2 Methods of Selecting a Menu Item or Action Bar Option

MOUSE
Use your mouse to move the pointer over the item. Then press mouse button 1 twice.

KEYBOARD
Press the cursor movement keys to mark (or highlight) the item and then press the **Enter** key.

FAST PATH
Press the letter or number that is underlined in the choice (usually, but not always, the first letter in the choice). A marked choice has a color bar over it.

Figure 10-1. Example of an OS/2 Selection Method Summary Chart

Special Key Functions

On devices that use the network, pressing certain keys or key sequences causes a device or program to perform particular functions. The user must know how to use these special functions in order to use the product.

The documentation for each network product should describe the special key functions for the product. You may want to provide to your users a summary chart of the special key functions for each product in your network, similar to the example shown in Figure 10-2.

Adapter and Advanced Diagnostics
Special Key Functions

ENTER	Executes each menu option. Always type the option number or letter; then press **Enter**.
F7	Moves display messages to left (color displays only).
F8	Moves display messages to right (color displays only).
CTRL + P	Directs screen output to printer.
CTRL + N	Cancels output to printer.
CTRL + C	Stops the tests and returns the diagnostics to Menu 2.
CTRL + NUMLOCK	Stops error log scrolling. To resume scrolling, press any key.

Figure 10-2. Example of a Special Key Function Summary Chart

User Assistance

Many of the network "problems" reported by its users will be misunderstandings and incorrect use of the network and its components. You should establish a means of answering questions from users about the operation and use of network equipment and programs.

You may want to combine this assistance with your network's problem reporting mechanism (see "Problem Reports" on page 11-5), or you may want a separate "Help Desk" name or telephone number to contact.

Some programs, like the IBM Distributed Console Access Facility Version 1 DCAF, allow one workstation to control and monitor the display and keyboard input of another. This capability provides a tool for centralized problem determination, debugging, and application assistance.

Network Security

Keeping your company's network assets secure requires planning, preparation, and procedures.

The security plans and procedures for your network may address:

- The physical facilities that house your network
- Network hardware
- Network software
- Data files
- Employees who design, supervise, operate, and use the network
- Access, use, and maintenance of the network in normal operation
- Operation, backup, and recovery in the event of abnormal situations, from minor damage and malfunctions to major loss or disaster.

The security plans and procedures for each establishment in your network should be practiced, documented, re-evaluated often, and updated frequently as your network grows and changes. The plans and procedures should include:

- Minimum impact on productive and efficient use of the network
- Methods for detecting and recovering from unauthorized or illegal penetration of security and use of the network.

Facilities

You must consider the methods you choose to secure the facilities housing your network as you plan and design the physical layout of your network (see "Planning the Network Layout" on page 8-6).

Considerations include:

- Access

  Locks or badge readers can be installed on doors of buildings, elevators, and rooms to protect and restrict access to equipment, cabling connection points, spare parts, telephone lines, and magnetic media. Keys, ciphers, or magnetic badges are then issued only to those authorized for entry or use. Authorizations should be reviewed and updated frequently.

  You may want to keep records of who has authorization to, and who actually does, enter certain rooms or use certain equipment or media. Signatures on authorization forms and sign-in/out sheets at access points are some ways of keeping such records.

  Installation of devices to detect unauthorized entrance can offer added protection. Such devices include traditional burglar alarms and more sophisticated sensors of changes in temperature, light, motion, and sound. Your local police department and commercial vendors of such equipment can guide you in selection, installation, and use.

- Construction and Environment

  The materials, construction methods, and layout used in a computer facility can help to prevent damage to equipment and provide a safe working environment.

  Use of nonflammable or fire-retardant materials in walls, floors, and furnishings can minimize the risk of fire damage. The computer facility should be located away from potential sources of water leakage (overhead pipes or basement ground seepage, for example). Installing drains, pumps, and detection and shutoff equipment helps to stop leaks quickly and remove water from the area.

  Proper selection and installation of systems for heating, cooling, ventilation, and humidity regulation in areas containing computer equipment is important. Controlling temperature and moisture fluctuations can prevent damage to electrical components and magnetic media, and provide a safer and more pleasant employee work environment.

  Limiting and removing dust, tobacco smoke, food, and other environmental pollutants in computer installations also contribute to preventing damage to equipment and magnetic media.

  Installation of detection and prevention equipment can minimize physical damage to an establishment from fire and the associated smoke and water. Early detection is crucial in these situations, as is prompt response to their occurrence. Systems and equipment used to put out fires should be appropriate to the environment; water and certain types of chemicals are not effective in combating electrical fires, for example.

  Fire detection systems can detect heat, smoke, or both, and can be combined with burglar alarm systems. Local police and fire departments and commercial vendors can help you with selection, installation, and use of detection equipment. They can also provide advice and training in fire fighting and prevention.

- Power Supplies

  Crucial to the operation of your network is its source of electrical power. Circuits and lines need to be:

  - Free from "noise" and extraneous signals on the lines
  - Shielded from external magnetic, electrical, and radio frequency fields
  - Protected from voltage surges, peaks, and fluctuations that can damage electrical equipment and magnetic media
  - Properly installed and grounded.

  Proper installation of cables (in cable bridges or under raised floors, for example) can prevent cable damage and employee accidents.

  Power sources to computer equipment, heating, cooling, lighting, and any other electrical equipment in the facility should have emergency power-off switches or buttons, conveniently located but protected from accidental activation.

  If continuous operation of computer equipment is critical to your establishment, you may consider including backup and uninterruptible power sources (batteries or generators, for example) in your network layout.

Hardware

The hardware used in your network may need protection from theft, from damage by those not trained in its use, and from use by unauthorized persons.

In addition to locks, access authorization, and intrusion detection for rooms and storage places containing the equipment, some other means of protecting equipment include:

- Installing locks on the power-on mechanisms of terminals and other devices, allowing only the persons with a key to turn the power on and use the device
- Fastening small equipment to large furniture, walls, shelves, or racks in such a way that tools and time are required to remove it.

Proper care of equipment can prevent damage and prolong usefulness:

- Run diagnostic tests frequently to prevent malfunctioning equipment from damaging magnetic media or data contents.
- Install surge suppressors and other voltage and power-regulating devices to protect sensitive electrical equipment and data files.
- Cover equipment that is not in use to minimize contact with dust and other environmental pollutants.
- Clean, align, and replace parts on a regular schedule (preventive maintenance).

You should establish procedures for:

- Controlling inventory, location, movement, and replacement of installed network equipment

  Each piece of equipment should be permanently labeled for easy identification; keep records listing each item, its label, and its current location.
- Controlling inventory and use of spare components.

Software

The software used in your network may also require protection from theft, damage, and unauthorized use.

Physical Media
As you prepare the working copies of programs on disks and diskettes, you will need to label the master and all copies in some way that identifies the contents, date, level, and perhaps the user or location of each. The labeling will help you in storing or filing the copies and originals, replacing damaged copies, updating to new levels, and assigning copies to authorized users.

Electronic and magnetic media deteriorate over time. To help prevent program malfunctions and data errors:

- Periodically copy originals to new diskettes and tapes, or purchase replacement originals of programs from the manufacturer.
- Rotate backup and working copies.
- Follow manufacturer's care and storage instructions for diskettes and tapes.

You may want to issue written authorization ("property passes," for example) to those who want to remove electronic media from the premises of your establishment, and set up a means of checking for the return of the media.

Using Programs
You can restrict the use of certain programs by:

- Limiting physical access to the devices that run the programs
- Limiting the distribution or use of the physical media from which the programs and files are loaded and accessed
- Using copyright-protected and write-protected diskettes and disk files, to prevent copying or alteration of programs
- Keeping program source files and executable files on separate disks or diskettes, with separate storage and access procedures
- Limiting access to the utilities used to copy, update, or erase files
- Requiring passwords and/or other information to be supplied as the programs are loaded or files are accessed
- Using other programs to track attempts to access restricted programs.

Certain network and application programs require passwords to permit use of some or all of the program functions. As you prepare working copies of software for your network, you will need to:

- Decide which programs or functions require passwords (see the documentation for the programs)
- Determine the format for and assign initial values of the passwords
- Establish a procedure for changing the passwords periodically
- Determine who will be authorized to know the passwords and use the restricted programs or functions
- Establish a method for recovering or changing passwords that are lost, forgotten, or expired.

Other information can also be required at the start of a program's use to identify authorized users (user name and program function selection, for example), to keep some statistics on the use of the program, and to provide information to the program (date, time, options, or parameters, perhaps). If this information is being used to restrict user access, the considerations for using passwords apply here also. Some programs, like IBM's Triumph workstation security program, provide:

- Security for DOS workstations
- Security administration from a central workstation.

Certain network programs can be used to grant access by:

- Limiting access to the network by disabling ports based on type, address, location, and time of day.

Data Files

Besides the physical restrictions, passwords, and authorizations that are used for equipment and programs, here are other methods you can use to restrict access to and protect data files used in your network:

- Creating separate directories and subdirectories for certain data files and limiting use of the directories can restrict use of sensitive data files.
- Write-protecting files can prevent the inadvertent erasure or overlay of a file when only read access is needed.
- Encrypting critical data can provide protection from unauthorized users while data is stored and during data transmission.
- Using device features such as auto-disconnect (breaking a telecommunication or telephone line connection when no activity has been detected on the line for a specified period of time) can help conserve resources, and can prevent unauthorized use of the network.
- Using program functions to verify data validity before and after file use or data transmission.

Personnel

The security of your network will depend greatly on the people using it. Once you decide what methods and procedures to use in your network, part of implementing them will be to provide the necessary information and education to network users. You may need to :

- Clearly inform each user of what he or she is authorized to do and use in the facility and on the network, as well as what he or she cannot do and use. Also explain how to obtain future authorizations.
- Instruct authorized users in the proper access, use, and operation of network facilities, equipment, programs, and files. Provide the required written instructions and documentation.
- Review with users any company policies regarding security breaches or misuse of the network.
- Review with supervisors the tracking, backup, and recovery procedures to be used (including the necessity for revoking user authorizations and network access immediately upon termination of employment).
- Provide access passwords and other identification, and instructions for changing the values or obtaining updates.
- Distribute physical media; provide instructions for its proper care and use and for obtaining updates and replacements.
- Provide training and drills in use of emergency procedures and equipment, evacuation plans, and backup and recovery procedures.
- Display phone numbers for police and fire departments, exit signs, caution and danger warnings, and other emergency information in prominent and appropriate places.
- Provide instructions and classifications to use in labeling media and printed material with assigned security levels. Provide appropriately secure storage and access for items of each level.

- Distribute tasks so that no one person has access to an entire sensitive process or project, and so that there is authorized backup coverage for critical tasks during employee absences.

Backup and Recovery

Keeping your network operating consistently also requires methods of quickly replacing, repairing, or providing alternatives for hardware, software, and data files.

You will need to consider carefully your network's critical requirements to:

- Assess the effects in time and cost of loss and damage
- Minimize loss and damage
- Balance the cost of implementing backup and recovery methods against possible losses.

You will need to instruct those responsible for backup and recovery in the tools, methods, and procedures you choose to use. This should include the use of special equipment and programs not authorized for use by other network users (utilities for copying and erasing files, and programs for recovering all or portions of erased or damaged files, for example).

Hardware Backup and Redundancy

In designing and maintaining your network, you may choose to:

- Provide spare devices to replace defective ones temporarily or permanently
- Create a backup plan for each device or application program, showing which programs can stop operating temporarily and which can be moved to other specified devices until problems can be resolved
- Design into your network more than one path between devices running critical application programs (redundancy)
- Arrange with other companies for reciprocal use of equipment while critical items are being repaired or replaced
- Locate rental equipment sources for emergencies.

Critical Programs and Data

As part of planning your network, you will need to decide how critical each application program is to the functioning of your establishment, and to determine what must be done to achieve the desired reliability and availability of critical application programs and data.

Properly preparing and maintaining working copies of the programs running on your network should adequately assure their operation, because programs are not often modified in the daily operation of the network (see "Preparing Programs for Workstations" on page 9-11 and "Software" on page 10-8). Data files, however, may be frequently modified.

For programs and data files, you will need to decide:

- When and how frequently backup copies should be made

  This may depend on how critical it is to recover the most current data in the event that the working copy is damaged or destroyed, on how long the backup process takes (backing up a full fixed disk can take considerably more than a few minutes), and on whether the operation of application programs can or must be interrupted to make the backup copy.

- What the backup media should be

  Small files may simply be copied to another disk or diskette. Larger files may need several diskettes or perhaps a magnetic tape. Fixed disks that have a lot of data on them can require more than 25 diskettes for backup.

- How many backup copies are needed, and where each copy should be located

  You may choose to keep one copy of critical programs and data in a building other than the one housing the computer facility. (If so, remember to replace it periodically along with any copies onsite.)

Managing Daily Network Operation

Managing the daily operation of a LAN primarily involves:

- Using observation and user feedback to determine that the network is accomplishing the work for which it is intended
- Making adjustments in physical layout and use of application programs to manage workload and data flow more effectively and efficiently
- Rapidly identifying and resolving problems that retard or interrupt the accomplishment of the work.

Much of the work done on a network involves transmission of data from one device to another. Therefore, one of the prime indications that the network is operating as intended is that data is being transmitted normally and correctly. Some observation of the operation of your network will help you determine what a normal rate of transfer is for each application program.

Most application programs and the programs that provide LAN segment status and error information will indicate detection of such conditions as traffic congestion, buffer overruns, invalid frames, and lost tokens. Most of these conditions are indicated as *soft errors* by the programs. They impede, but do not necessarily stop, communication over the LAN segment.

These conditions may possibly be corrected by the network software and microcode (retransmitting data, for example) without any human intervention. If a condition cannot be corrected without human intervention, one or more messages or codes will describe the condition. The software and microcode may remove from the network one or more adapters that are suspected to be causing the condition. Or the indication may just be multiple messages and codes describing the condition.

Your knowledge of the application and support programs used on the network can be invaluable in resolving such network conditions.

Management Tools

Network manager programs, bridging products, and trace and performance tools can help you evaluate and manage the traffic on your network.

The IBM LAN Manager and the IBM LAN Network Manager collect LAN segment status, adapter status, and error information for the LAN segment to which the network management program is attached. These programs can also receive similar status and error information for remote LAN segments by establishing communication links with the bridges that connect the remote LAN segments. In addition to status and error information, the IBM LAN Manager and the IBM LAN Network Manager can receive counts and statistics about the traffic flowing through each bridge with which a link is established.

The IBM 8209 LAN Bridge, the IBM Token-Ring Network Bridge Programs, and the IBM PC Network Bridge Program each connect two LAN segments, and contain functions to:

- Collect LAN segment status and error information for each LAN segment
- Collect bridge traffic counts and statistics

- Allow up to four communication links to be established with network manager programs (such as the IBM LAN Manager)
- Send status, error information, and bridge traffic information to the network manager programs with which links are established.

The bridge programs also contain display functions for the status, error, and traffic information.

The network status, adapter status, and error information collected by the IBM LAN Manager and a bridge or by the IBM LAN Network Manager and a bridge can indicate that:

- A LAN segment is inoperative or not operating normally
- A bridge has stopped operating
- Soft errors are increasing on a LAN segment.

The bridge traffic counts and statistics can indicate:

- Relative traffic loads on various bridges (you can compare counts from each bridge)
- Causes of frames not being forwarded through a bridge
- Proportion of broadcast and non-broadcast frames crossing a bridge.

The IBM LAN Manager and the IBM LAN Network Manager can remove malfunctioning adapters, collect additional soft error information, or reroute single-route broadcast bridge traffic.

The IBM Token-Ring Network Trace and Performance Programs can provide (for a single 4- or 16-Mbps ring):

- A trace of the contents of the frames on the ring (including control and routing fields, data fields, or both)
- A display of the current ring utilization, and ring frame and byte counts over time.

The Advanced Diagnostics packaged with the *IBM PC Network Hardware Maintenance and Service* manual contain a function to measure low, high, average, and present percentages of bus utilization. The displayed percentages are updated as bus utilization changes.

These tools can help you quickly locate the source of a network overload or malfunction, and help you provide both temporary and permanent solutions.

See Part 3 of this manual for more about the functions and use of these programs.

Distribution of Traffic on the Network

As you plan, install, and manage the daily operation of your network, one of your main concerns is the volume and flow of the traffic on the network. You will need to consider:

- LAN segment utilization

  Limiting the average utilization of a LAN segment to less than 30% of its capacity allows for expansion and for peak or temporarily increased workloads.

  Although LAN segments can operate error-free with no data loss at 100% capacity, data transfer times and response times can increase significantly as utilization exceeds 70%.

  Note: Data overruns and slow response times are not caused by the LAN segment data transmission rate slowing down. A LAN segment always transmits data at its specified data rate. Overruns and response times are affected by the speed at which application programs and interfaces can process data, given the resources allocated to them (such as buffers, SAPs, and link stations) and the values specified for configuration parameters.

  The *IBM Token-Ring Network Introduction and Planning Guide* describes a method of estimating the utilization (traffic load) of each ring in a network before the ring is installed and operating.

  The IBM Token-Ring Network Trace and Performance Programs (for 4- and 16-Mbps rings) and the IBM PC Network Advanced Diagnostics Network Utilization function can be used to monitor and display the actual LAN segment utilization for a single segment.

- Servers, bridges, gateways, and remote connections

  Most of these combinations of devices and software transfer or process data at a slower rate than the transmission data rate of the LAN. This is particularly true if the data transfer from the network through a gateway device, a remote connection, or a bridge involves a telecommunications link.

If the time required for data transfer seems to increase significantly, you should:

- Reevaluate the utilization of the LAN segments involved.

  You may need to move devices from one LAN segment to another or create a new LAN segment to reduce utilization on each LAN segment.

- Check for one device that is overloaded with data (a file server receiving data from many users at once, for example).

- Check for transfers of very large files during peak traffic periods. Such transfers may cause congestion on the network, particularly at points such as bridges, gateways, or output devices (like printers).

- Check settings of parameters and options for conditions such as:

  - Buffer allocated in adapter or computer memory for data transmission, receipt, or processing (too few can cause excessive data retransmission; too many can take up computer memory needed for other uses).

  - Maximum message sizes set differently at sender and receiver; the two application programs were not written to negotiate to the smaller size before transmission (for example, NETBIOS negotiates).

- Pacing windows or other flow control mechanisms either set incorrectly or not set when they should have been.

- Incompatible resource allocations that can cause data overruns and retransmissions (the adapter is probably NOT broken).

  Any level of programming, interface support, or adapter microcode can allocate resources, process data, and report error conditions. An allocation error in one level can cause errors to be detected and reported by another level. For example, if buffers and sessions are allocated so that the receiver cannot process and clear buffers as fast as data can be sent, overruns will be reported by the application program; the allocation problem may be in another level. (See Figure 11-3 on page 11-8.)

Chapter 11. Network Problem Analysis and Resolution

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Planning for Problem Reporting and Resolution

Planning for your network should include creating for your establishment a procedure by which network problems are reported and resolved. Figure 11-1 suggests appropriate contents of such a procedure. You may include some or all of these items in your procedure, and you may add other items that are not listed.

A problem reporting and resolution procedure for your establishment might include:

- Instructions for reporting a network problem
  - A telephone number and name of a person to contact to report the problem
  - What information to provide to the person who answers the call
- Instructions for receiving and recording a problem report
  - How to record reported information in a log or on a form
  - What action the reporter of the problem is to take next
  - How to begin problem resolution
- Assignment of activities during problem resolution
  - What action network users are expected and allowed to take before reporting a problem
  - Who is responsible for specific activities after a problem is reported
  - What activities you (the network administrator) participate in after a problem is reported
- Items and information required for problem resolution
  - List of materials needed for problem determination
    - Charts of the network organization and layout
    - Spare components for testing or replacement
    - Problem determination procedures
    - Software and hardware documentation
  - Locations and instructions for obtaining the materials
  - Instructions for updating charts and other documentation when resolving the problem results in a permanent change to the LAN segment or network configuration
- Guidelines for removing and inserting portions of a LAN segment during problem resolution
  - Notifying users that a portion of a LAN segment or network will be inoperative for a time
  - Notifying users that they may see intermittent errors while the problem is being corrected
- Instructions for notifying the network administrator when documentation and online messages say to do so; the instructions should contain:
  - Your name, telephone number, and location
  - What information to give to you when someone notifies you of an event
  - What action you are to take when you are notified of an event
- Instructions for obtaining outside assistance if you cannot resolve the problem
  - Telephone numbers, addresses and locations of:
    - Places of purchase
    - Service suppliers
    - IBM branch offices or representatives
  - Paperwork and information required
  - Instructions and materials for packaging and returning defective software or hardware products.

Figure 11-1. Suggested Contents for an Establishment Problem Resolution Procedure

Determining Whether There Is a Problem

Your first indication that there is a problem will probably be from a network user reporting that a device or application program:

- Is no longer working at all, and may have been removed from the network
- Is not working as it normally does (slow or erratic operation)
- Is indicating an error condition.

The network user reporting a problem will usually describe the problem in terms of symptoms rather than causes. For example:

- My device or application program is doing things more slowly than normal (slow response time).
- My device or application program is not operating at all any more (hard error).
- My device cannot communicate with another device (cannot establish a session).
- My device's communication with another device just stopped; I didn't do anything to stop it (session terminated abnormally).
- My device displayed a message that I have never seen before.
- Data is wrong in the message or file I just received (application program or parameter error).

For networks that contain connections to S/370 host computers, some programs can send *alerts* to a host that is running the IBM program called NetView. An alert is an indication of a problem or an impending condition that, if not corrected, will soon result in a problem somewhere on the network.

The IBM LAN Network Manager 1.0, IBM LAN Manager (Versions 1.0 and 2.0), the IBM LAN Manager Entry, and the IBM PC 3270 Emulation LAN Management Program can send alerts to NetView containing information about the type of error or condition, the adapters and the portion of the LAN segment involved in the problem, and recommended actions for resolving the problem.

Problem Reports

When a network user reports a problem, you may want information about the problem recorded in a log or on a form. The recorded information helps in resolving the problem, and provides a history for later reference. The problem information might include:

- The user's name and telephone number
- The location and identification number of the device having the problem
- Any symptoms of the problem
- The user's entries, responses, and actions immediately before and after the occurrence of the problem
- The environment or configuration of the device (device type, application programs used and for what purpose — print server, for instance).

A sample Problem Report form that you might use or modify for your establishment is shown on page 11-6. Some of the information may be supplied by you or others doing problem analysis, and not by the user reporting the problem.

You may combine problem reporting with a user "help desk" or other question-answering facility. In any case, you need to establish a way for users to quickly and easily report network problems.

You may include problems indicated by alerts at a host NetView console in the same network problem log, or you may handle them separately. Your problem resolution procedures also need to include instructions for resolving problems on remote LAN segments (where the first indication of a problem in your establishment is at a host computer in another building, city, or state and where problem resolution may involve telephone conversations between the locations to isolate and correct the problem).

IBM Local Area Network
Problem Report

1. User's Name ______________ Location ______________
   Telephone ______________ Department ______________ Date ______________

2. Attaching Device Information

   Type ______________ Location ______________ ID ______________
   Application programs ______________
   Device function:

   ________ Terminal
   ________ Server, Type ______________
   ________ Bridge
   ________ Interconnect
   ________ Controller
   ________ Other ______________

3. Problem Description

   a. Device operation _____ Abnormal, _____ Inoperative

   b. Symptoms ______________

   c. User actions or entries:
      Before error ______________

      After error ______________

   d. Error indications:
      Message: ______________
      Variable data: ______________
      Fault domain: ______________
      Reason or return code: ______________
      Other: ______________

   e. Other devices having problem _____ One, _____ Some, _____ All, _____ Don't know

   f. Number of LAN segments in network _____ One, _____ How many

   g. Are the problem devices:

      _____ All on same LAN segment
      _____ On different LAN segments

   h. Relationship between devices:

      _____ Use same resource, application program
      _____ Attached to same access unit

Figure 11-2. Sample Local Area Network Problem Report Form

Determining the Nature of the Problem

A primary task in LAN problem resolution is to use the reported symptoms to help determine the type or nature of the problem. The nature of the problem usually indicates the procedures you need to use to isolate and resolve the problem.

Generally, the symptoms will indicate clearly whether the error is a hard or soft error, a hardware or software error, or a user error. In some cases, you may have to use procedures to determine the nature of the error.

Hard and Soft Errors

Non-Recoverable Errors: Network errors that stop operation of a LAN segment, device, or application program.

Recoverable Errors: Errors that impede but do not stop network, LAN segment, device, or application program operation.

The table below lists some of the probable causes of non-recoverable (hard) and recoverable (soft) errors.

Error Cause	Hard	Soft
Invalid user entries or responses	X	X
Incorrect use of hardware or software function	X	X
Changes in network configuration	X	X
Session or application program timeouts		X
Traffic overload on portions of the network	X	X
Changes in traffic/workload profile	X	X
Environmental conditions (such as electromagnetic radiation, temperature extremes, and others)	X	X
Software abends and other errors	X	X
Hardware component defects or failures	X	X

Note: For the IBM Token-Ring Network, data overruns and slow response times are not caused by the LAN segment data transmission rate slowing down. The LAN segment always transmits data at either 4 or 16 Mbps. Overruns and response times are affected by the speed at which application programs and interfaces can process data, given the resources allocated to them (such as buffers, SAPs, and link stations) and the values specified for configuration parameters.

Hardware, Software, and User Errors

Hardware Errors: Errors or failures in the operation of a hardware product. Hardware failures can result in soft and hard network errors.

Software Errors: Errors or failures in the operation of a program. Software errors may be caused by incorrect operation of program functions, resulting in soft errors involving data transfer, traffic flow, and session and link communication. Software errors may also be hard errors, such as program abends.

User Errors: Errors resulting from invalid entries on application program panels or menus, invalid responses to application program prompts, or incorrect use of software or hardware functions. User errors can result in either hard or soft network errors.

As shown in Figure 11-3, errors can originate from five major levels of the network. Isolating an error condition to a level and then to a component in that level helps you determine what procedures, programs, and documentation to use to resolve the problem.

User, application program, and device problem determination procedures are usually described in the documentation packaged with each hardware and software product.

IBM LAN problem determination procedures and diagnostic tests are used primarily to isolate and correct problems in adapters and network components.

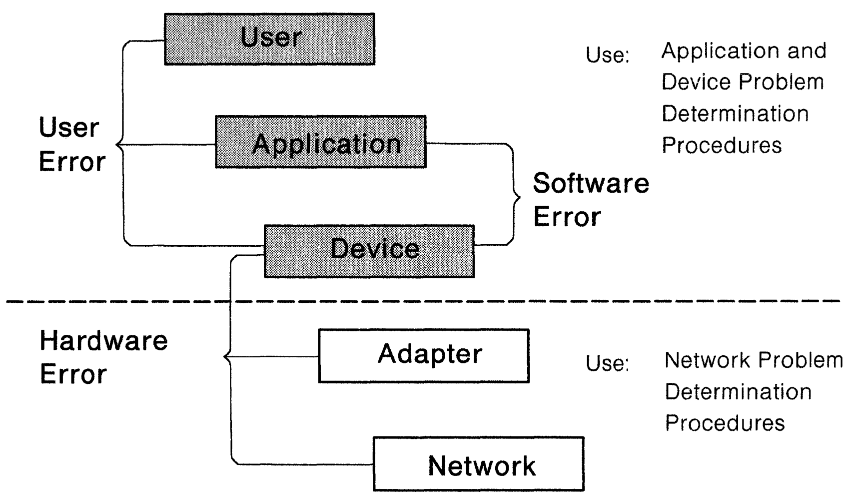

Figure 11-3. Major Levels of the Network in Which Errors Can Occur

User Level Errors
User or operator errors may occur in an entry on a software panel or menu, in a response to an application program prompt, or in the use of the functions of an application program or a device. The incorrect use of device or program functions may result in the device or program actually operating incorrectly, or the result may be user frustration when the device or program operates correctly, but not in the manner the user expected.

Many network user "errors" are simply the user's misunderstanding or lack of information on the correct use of an application program or a device. You can eliminate most of these user errors by providing your users and operators with:

- Education and instructions on the use of network hardware and programs
- A "help desk" or other type of contact to answer questions about the use and operation of the network.

See "User Education, Procedures, and Assistance" on page 10-3 for more information about user assistance and education.

Application Program Level Errors
Errors may result from incorrect operation or failure in application programs and software interfaces themselves. Application programs often display information about errors in the other four levels. The application program may detect the errors, or the other levels may pass information to the application programs about detected errors. Thus, application programs provide many error indications, although the origin of the error may be elsewhere in the network.

Information displayed by an application program is a good first indication of the cause of a problem, and frequently is sufficient to locate and resolve the problem. Documentation packaged with application programs, interfaces, and hardware products usually explains the information displayed by the application program, and provides or directs you to procedures and actions to use to resolve a problem. The procedures and actions may ask you to:

- Run hardware diagnostic tests on a device to isolate a failing component
- Restart an application program after verifying or changing configuration parameters or options
- Retry a previous entry, response, function, or action
- Check cable and outlet connections and device switch settings.

Device Level Errors
Devices that connect to a LAN usually consist of hardware and software components that can operate independently of the network (IBM Personal Computers and DOS, for example). These components also provide support to the hardware and software that connect to and run on the network. Errors and failures can occur in the device hardware, in the operating system, or in supporting programs that run in the device.

Each device and supporting program is usually packaged with documentation that explains error indications and provides procedures and actions to use to resolve the problem. Hardware products may also include diagnostic tests to help isolate a hardware failure.

Adapter Level Errors
The adapter and cable that connect the attaching device to the network can fail. These hardware errors may be indicated directly by information displayed by an application program. Or these errors may cause other errors indicated by the application program (soft errors such as incorrect data or intermittent transmission problems).

Diagnostic tests are usually provided to help you isolate a network adapter failure. Depending on the type of adapter and the type of computer in which it is installed, the diagnostic tests may run:

- During power-on tests whenever the computer power is turned on
- From diagnostic diskettes supplied with the adapter
- As system tests selected from the computer's Reference Diskette.

The operator's guides, installation and test instructions, and service instructions packaged with and related to adapters and devices describe the diagnostic tests and procedures needed to identify their adapter and connection problems.

Network Level Errors
The access units, repeaters, and cables that connect to form the network can fail to operate correctly.

The *IBM Token-Ring Network Problem Determination Guide* contains procedures that help you isolate and replace or repair a failing IBM Token-Ring network component. The *IBM PC Network Hardware Maintenance and Service* manual contains procedures that help you isolate and replace or repair a failing IBM PC Network component. Most of these problem determination procedures require information about the status and operation of a network and its components. You may use the Ring Diagnostic and programs such as the IBM LAN Network Manager 1.0, IBM LAN Manager, IBM LAN Manager Entry, IBM Token-Ring Network Bridge Program, or IBM PC Network Bridge Program to obtain and display such information. Or, you may write your own program to gather and display this information.

See "LAN Segment Status and Error Information" on page 11-16 and Appendix A for information about programs that provide LAN segment and error status. See "Programs That Provide LAN Segment Status and Error Information" on page 9-22 for information on how to write your own program.

Isolating and Resolving the Problem

In your establishment problem resolution procedure, you should designate and assign activities to the people who will do problem resolution. The procedure should be clear on:

- What a network user is expected or allowed to do before reporting a problem

  Care should be taken to preserve information that may be needed to isolate and resolve the problem. For example, trying to reload a program that has failed may destroy a memory dump or error message that is needed to identify and correct the problem with the program.

- Who is responsible for specific activities after a problem is reported

  If others are assigned problem resolution tasks, you may want them to notify you only if they cannot resolve the problem, or if the error explanation or procedure instructs them to call you. You may assign basic resolution procedures to others, and restrict your direct participation to the more difficult procedures or to resolutions that require your overall knowledge of the network.

Information and Materials Required for Problem Resolution

You and any others who do network problem resolution will require certain information and materials.

As illustrated and described in Chapter 1 the reported symptoms of the problem generally indicate:

- The nature of the problem (user, hardware, software, hard error, or soft error)
- The portion or level of the network where the problem occurred (user, application, device, adapter, or network).

Once you understand the problem, you can use the symptoms, product publications, and network documentation to locate the problem and begin the required problem determination procedures.

- The reported symptoms, status, and error information

  The answers to the questions in Figure 11-4 on page 11-13 may help you isolate the problem to a device, a LAN segment, an application program, or a portion of the network. The user reporting the problem can provide some of the answers. Other answers require your knowledge of the network configuration and of the relationships between application programs and between portions of the network.

  Alerts sent to a host computer from a program on the network provide an indication of the nature and location of the problem. Investigation is usually required at the problem location to completely isolate and resolve it.

- Publications

  The publications packaged with programs and hardware products explain the meanings of status and error information, recommend corrective actions, and describe the problem determination procedures for resolving user errors, program problems, and hardware failures.

Network publications such as *Hardware Maintenance and Service* manuals and *Problem Determination Guides* contain procedures for isolating, repairing, and replacing failing LAN adapters, cables, and other network hardware components.

- Network layout and organization documents, including
  - Building floor plans for your establishment
  - Cabling, location, configuration parameter, and addressing charts.

Once you begin the indicated problem determination procedures, you may also need:

- Programs that provide LAN segment status and error information (such as the IBM LAN Network Manager 1.0, IBM LAN Manager, IBM LAN Manager Entry, or IBM Token-Ring Network Ring Diagnostic)
- Spare components for testing and replacement
- Hardware diagnostic tests
- Application programs to use to verify LAN segment and network operation.

During problem determination and resolution you may also need to supply:

- Replacement labels for network components and cable connection points (such as lobes or faceplates)
- Blank charts for updating network layout documentation
- Blank formatted diskettes (used for making working copies, storing data files, and for memory dumps when some programs detect program errors)
- Original diskettes or masters of working copies, and backups of fixed disks.

Questions to Ask during Problem Isolation

1. Has any part of the network changed recently?

   Suspect the problem to be in the part of the network that changed, especially if the device reporting the problem was involved in the change. Verify that the change was made correctly. Verify also that LAN segment sizes, utilization, and configuration parameters are still valid or within limits after the change.

2. Can the problem be isolated to one LAN segment, several connected LAN segments, or connections between networks?

   One LAN segment – Errors are in one device, a group of related attaching devices, or in network components.

   Two or more LAN segments – In networks consisting of two or more LAN segments joined by bridging products, errors can be those cited above for one LAN segment. Errors can also occur in:

   - The hardware and software that form the bridges
   - The layout of the physical connections between attaching devices (paths)
   - The specification of bridge program configuration parameters that affect general network operation (see "Bridge Definition and Documentation" on page 15-19).

   Connections involving hosts, controllers, and remote connections – Errors may occur in hardware and software used to connect controllers to LANs, LANs to WAN or asynchronous hosts, and remote devices to LANs.

   The error could be in the LAN, in the connected device, or in the hardware and software that make the connection.

3. How many devices are experiencing a problem?

   One – The problem is probably in the device, the adapter or cable, or the application program run in the device.

   Two – The problem may be in allocation of the resources used by the two devices to establish communication (buffers, SAPs, link stations, and so on). The problem may also be that a portion of the network between the two devices has failed, blocking communication.

   Several – See if there is a relationship between the devices:

   - They all use the same server
   - They are all in the same affinity group or department
   - They all use the same application program
   - They all use the same bridge or gateway
   - They are all on the same LAN segment.

   The relationship may indicate the nature or location of the problem (an application program or server, perhaps). If all of the devices are not on one LAN segment, a portion of the network between the devices may have failed and blocked communication.

   All – If all devices on one LAN segment are not operating normally, there is probably a network component failure, or a hard error in one or more attaching devices.

Figure 11-4. Questions to Ask during Problem Isolation

Problem Determination Procedures

The publications packaged with hardware and software products used in the network usually contain:

- Explanations of error codes, messages, and indicators displayed by the program or hardware
- Actions or procedures for identifying and resolving errors and problems.

On a LAN, devices that have displays and run programs can usually indicate clearly the nature and location of a problem in the device or program. They can indicate to some degree the status of other devices and of the network. Devices that do not communicate directly with end users (such as controllers) must provide status and error information either to an end-user device or to a host computer for display or logging.

To resolve a network hardware component failure, network problem determination procedures generally:

- Require information about the operating and error status of a LAN segment and its components
- Use the LAN segment status and error information and the network documentation to isolate the problem to a LAN segment
- Remove that LAN segment, allowing the rest of the network to continue to operate
- Isolate the problem to a component in the removed LAN segment
- Indicate how to repair or replace the component
- Insert the repaired LAN segment back into the network.

Most procedures are designed for use in networks that contain at least one workstation and use a program to provide LAN segment status and error information. There are, however, procedures for networks that do not use programs that provide LAN segment and error status. These procedures usually involve isolating failing components by a process of elimination.

You and all other people responsible for network problem determination should familiarize yourselves with the problem determination procedures for your networks before having to resolve a problem. Network problem determination procedures are performed most easily and efficiently when certain materials and information are available to use with them. The following sections describe those materials and information.

Network Planning and Layout Documentation

Building Floor Plans

Building floor plans showing the location of each attaching device, hardware component, and cable in your network can help you quickly locate a suspected failing component.

For a small network or LAN segment, you may be able to mark all devices, cable connection points, cables, labeling information, and addresses on the floor plans. For larger networks, you will probably need additional charts and worksheets to document cabling sequences, addresses, and configuration parameters.

Charts and Worksheets

Charts and worksheets that you complete during network planning and installation in your establishment can help during problem determination procedures to:

- Identify and locate the portion of a LAN segment that might contain the failing component, and the failing component itself
- Locate the devices containing adapters identified by addresses in the LAN segment status and error indications
- Verify that this LAN segment is correctly cabled, particularly if this portion was recently changed or added to the network
- Verify that the network has been restored to the documented layout if no layout or component changes were required for resolution.

You will need to provide copies of the completed charts and worksheets for use during problem resolution. Some charts may need updating if changes are made in the network to resolve a problem (for example, replacing a LAN adapter will change the universally administered address associated with an attaching device). You will need to provide blank charts and worksheets for updates during problem resolution.

If your establishment uses a labeling scheme different from that described in the IBM *Network Planning* and *Cabling System* manuals, you may need to explain your scheme to others participating in the procedures, so that they can use the charts along with the problem determination procedures.

LAN Segment Status and Error Information

LAN adapters are designed to obtain certain status and error information about attaching devices and about the LAN segment to which they attach. The adapters then provide this information to certain programs that request it. At least one program that gathers LAN segment and error status should be available for each LAN segment in your network at all times.

- These programs may help you resolve minor problems before they become serious.
- Some programs can collect data over a period of time to provide additional information about the cause of the problem.
- The procedures that do not use program information to help locate a failed network component take significantly more time to perform than those that do. You may not be able to isolate the problem to a LAN segment, and you may have to check every LAN segment component by the process of elimination.
- Although alerts at a host computer can give a first indication of a problem, information from a program on the LAN segment at the problem location may be required to diagnose the problem.

Some programs, such as the IBM LAN Network Manager 1.0 and IBM LAN Manager, can provide status and error information concurrently for multiple LAN segments, and can send alerts to a host computer. Other tools, such as the IBM Token-Ring Network Ring Diagnostic, report status and errors only for the LAN segment on which they are running.

You will need to work with the network planner to:

- Choose the programs to provide LAN segment and error information for your establishment
- Locate the programs appropriately in the network for complete network coverage and for easy access during problem determination.

The devices used for running the LAN segment status and error information programs should:

- Be convenient to you or to an operator
- Have a printer attached for recording problem information
- Be near a telephone (to receive user problem reports and to communicate with others involved in network problem resolution. Network problem determination procedures are often most efficiently and easily performed by two people working together.)

Spare Components

You will need spare cables for testing and replacement during problem determination procedures. You may also choose to have spare adapters and network hardware components available to speed resolution of a problem and to keep your network in operation while faulty components are repaired or exchanged.

Planning for your network should include ordering spare components. You and the network planner will need to decide which ones and how many to order. You need to arrange for storage of the spare components, provide them as required, and replace them as they are used in the network.

Adapter Diagnostics

Network problem determination procedures and some of the explanations for application program error messages and codes may ask you to run adapter or system diagnostic tests to identify a suspected adapter problem. The device containing the adapter being tested is not attached to the network and cannot run any application programs while the test is performed.

Make diskettes or files containing working copies of these diagnostics available to those performing network problem determination procedures. Store the original diskettes or files in a safe place, so they can be copied again in the event of damage to the working copies. Instructions packaged with the diagnostic tests or with the device in which the adapter is installed explain how to make working copies.

You should run the adapter diagnostic tests:

- After installing an adapter
- After repairing or replacing an adapter
- To identify most suspected adapter problems.

Errors detected by the diagnostics are logged in memory. You may then print this information or write it on a disk or diskette.

The diagnostic tests display information that allows you to:

- Determine the adapter address (universally administered)
- Verify settings and values specified for adapter configuration options.

Note: The diagnostics show only the universally administered address for an adapter (not a locally administered address).

“Notify Your Network Administrator”

Many of the problem determination procedures and error indication explanations say to “Notify your Network Administrator” if:

- Additional information or materials are needed to continue the procedure
- A temporary or permanent resolution to the problem will change the network or LAN segment layout. You will need to participate in
  - Making the change
  - Updating the network layout and configuration documentation.
- A temporary or permanent resolution to the problem will change configuration parameters for one or more application programs. You will need to participate in deciding
  - What the change should be
  - Whether the change is permanent or temporary
  - What procedures or documentation need to be updated.
- The procedure has not identified or resolved the problem. You may need to
  - Verify that problem determination procedures were performed correctly
  - Perform another procedure
  - Call IBM or a service supplier for assistance.
- Spare parts or components are used in the problem resolution. You will need to
  - Provide the items used in the resolution
  - Order replacements for the items used.

Note: The recommended action for many of the alerts sent to NetView from a LAN is, “Notify the Network Administrator.” You will need to supply the NetView operator with the name and telephone number to call (you or someone you designate).

The action is limited that a NetView operator can take to resolve a LAN problem from the NetView host. The operator can provide the information from the alert when he calls you, and may be able to query certain LAN programs for additional network status.

The operator may also be able to remove an adapter (logically) from the network. You may want to discuss LAN problem resolution with the NetView operator, and include some NetView operator instructions in the problem resolution procedure for your establishment.

Your problem reporting and resolution procedures should include instructions for how and when you are to be notified. The procedures should also indicate what action you will need to take when you are notified.

Obtaining Outside Assistance

Your establishment procedure should include instructions for obtaining outside assistance when the problem determination procedures do not resolve the problem.

The hardware and software products used in your network come with various statements concerning licensing, warranty, service, replacement, and repair information. This information includes requirements, restrictions, and provisions for your use of and the manufacturer's support, repair, and replacement of a product. It may contain procedures to follow when returning defective items, along with telephone numbers and addresses of service and component suppliers.

You may also purchase service and maintenance from your place of purchase or service supplier. The service or maintenance terms are usually stated in some form of agreement at the time of purchase. For example, warranty and maintenance service for a defective access unit purchased from IBM can be obtained by contacting the IBM Service/Exchange Communication Center; assistance with maintenance for IBM Cabling System components can be obtained by contacting your local IBM service office.

Proofs of purchase, sales receipts, warranty or service registrations, and forms to complete for service or component replacement should be kept in a safe and convenient place. You may need them to obtain service or replacements for defective products, or to obtain assistance in resolving problems with a product.

Part 3 — Support Programs, Interfaces, and Operating Systems

Chapter 12. Adapter and Device Support Programs

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The following support programs operate with the indicated LANs.

Support Program	IBM Token-Ring Network	IBM PC Network		MAP	Ethernet
		Broadband	Baseband		
IBM Local Area Network Support Program (DOS) or OS/2 Communications Manager	Yes	Yes	Yes	No	Yes
IBM PC Network Protocol Driver	No	Yes	No	No	No
IBM 9370 Token-Ring Subsystem Support Program	Yes	No	No	No	No
IBM VTAM and IBM NCP Programs	Yes	No[1]	No	No	No
IBM NCP Network Token-Ring Interface (NTRI)	Yes	No	No	No	No
IBM 3174 Utility/Diagnostic and Control Microcode	Yes	No	No	No	No
IBM S/36 or 38 LAN Communication Program	Yes	No[1]	No	No	No
IBM AS/400 PC Support Program	Yes	No[1]	No	No	No
IBM Series/1 Token-Ring Interface Program	Yes	No	No	No	No
IBM LAN Channel Support Program	Yes	Yes	No	No	Yes
IBM 3172 Interconnect Controller Program	Yes	No	No	Yes	Yes
Remote Program Load	Yes	No	No	No	No

1. This program gains access to the LAN through a secondary connection to a network workstation that is running 3270 emulation.

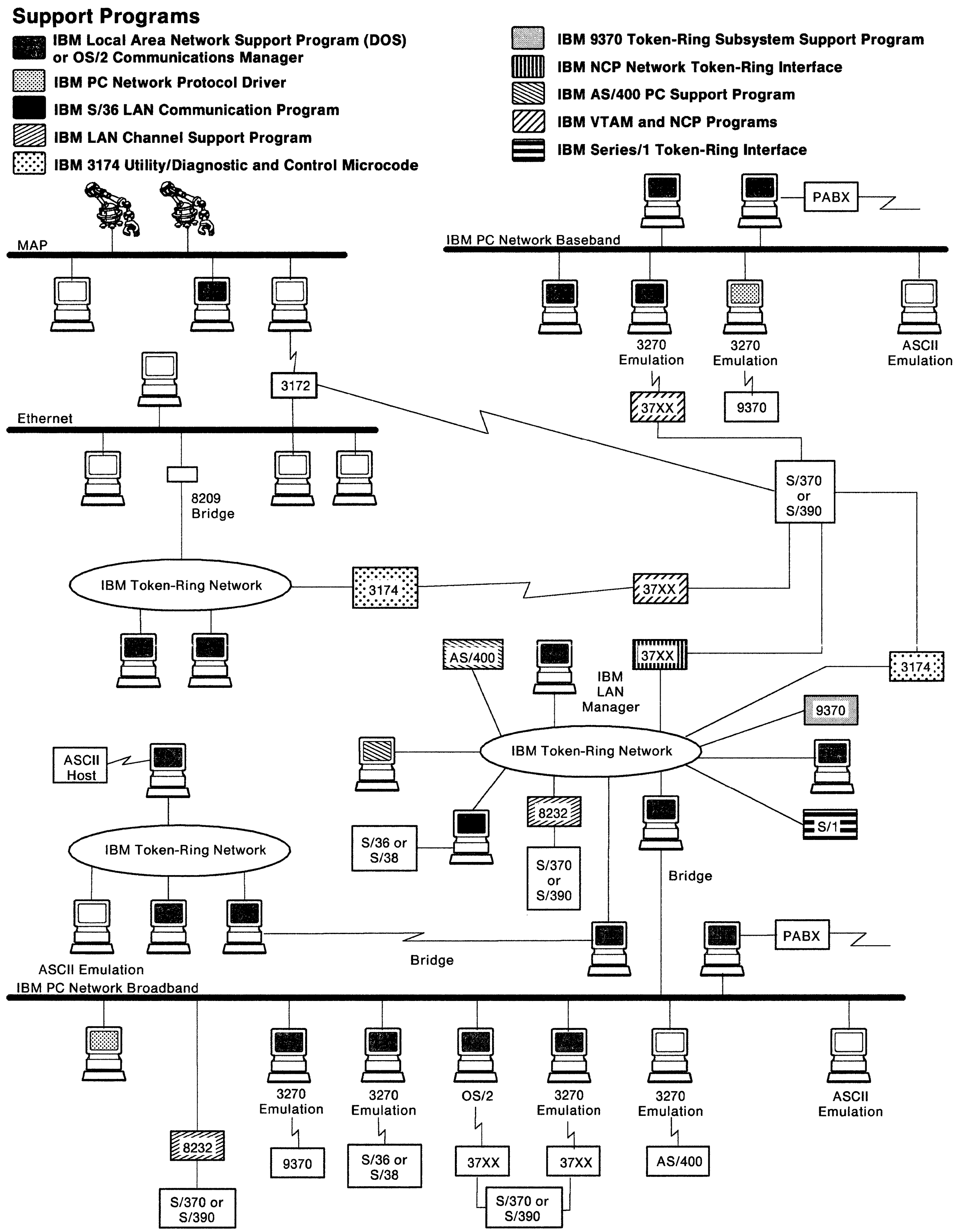

Figure 12-1. Support Programs Used on a LAN

Overview of the Support Programs

This chapter describes programs that provide standard interfaces and support for:

- Communication on the network
- Communication between application programs and network adapters or features.

The table on page 12-2 identifies the support programs that operate with each of the indicated LANs. Figure 12-1 shows where each support program could be installed on the equipment connected to a LAN. The remainder of this chapter discusses each program in detail.

If you need to know more about a specific support program, go directly to the section that describes that program. Each program's characteristics are described independently. You do not need to read about all the support programs to understand what any one does. However, you may want to read about all of them when picking a program to serve your specific needs.

Some of the support programs enable direct communication between attaching devices on one of the LANs. A **Yes** in the table on page 12-2 indicates programs of this type.

Some of the programs require an additional program in the same attaching devices or in an intermediate device to enable communication between attaching devices. A **No**[1] in the table indicates this type of program (See note on page 12-2).

Some of the programs cannot establish communication on a particular type of LAN. A **No** in the table indicates program not compatible with a particular network.

The IBM Local Area Network Support Program

The IBM Local Area Network Support Program enables direct communication for DOS-based devices on either the IBM Token-Ring Network, the IBM PC Network Broadband, or the IBM PC Network Baseband. It also provides a program interface to support Ethernet Network application programs on some Ethernet Network adapters. Refer to the *IBM Local Area Network Support Program User's Guide* for a complete description of this program.

Note: For OS/2-based devices, the IBM OS/2 Communications Manager provides an equivalent level of support. See Chapter 17 for a more detailed description of OS/2.

The IBM Local Area Network Support Program (or LAN Support Program):

- Provides workstation adapter support and associated program interfaces (NETBIOS, IEEE 802.2, LLC) for the IBM Token-Ring Network, the IBM PC Network, and the Ethernet Network
- Gives application programs access to network adapters
- Allows programs written for one type of network to run on the other networks.

The LAN Support Program files are a group of *device drivers* for LAN adapters. (A device driver provides a software interface between the computer and an attached device or feature, such as a printer, keyboard, or adapter.)

The LAN Support Program provides a Configuration Aid that simplifies the configuration process. This Configuration Aid helps create the DOS CONFIG.SYS file that must contain the load commands for the device drivers. Each load command includes the name of the device driver and any load parameters used to allocate resources or select functions at load time. You may configure the LAN Support Program manually, without the Configuration Aid. Note that you must configure the LAN Support Program manually if you are using the IBM Personal System/55* computer.

As DOS is loaded into the computer, DOS reads the CONFIG.SYS file and loads the device drivers with the appropriate functions and resources specified by the device driver load parameters.

The DXMINFO.DOC is an information file supplied on the LAN Support Program diskette that describes how to code the load parameters for the device drivers in order to customize the installation of the Support Program.

LAN Support Program Device Driver Summary

The LAN Support Program has eight different device drivers:

- The interrupt arbitrator DXMA0MOD.SYS, required in all installations of the Support Program
- PC Network adapter device drivers DXMG0MOD.SYS (for Adapter II and Adapter II/A support), DXMG1MOD.SYS (for support of 3270-PCs and other workstations that use the IBM 3270 Workstation Program), and DXMG2MOD.SYS (for original PC Network Adapter support)
- Token-Ring Network adapter device drivers DXMC0MOD.SYS and DXMC1MOD.SYS (for 3270-PC support)
- The NETBIOS interface device driver DXMT0MOD.SYS.

- The Ethernet adapter device driver DXMEOMOD.SYS. Note that the following additional NDIS device drivers are needed with the DXMEOMOD.SYS device driver:
  - PROTOCOL.INI,
  - PROTMAN.EXE
  - NETBIND.EXE.

IBM Token-Ring Network Device Driver Parameters

On the load commands for the IBM Token-Ring Network device drivers, you can specify for the primary and alternate adapter:

- A locally administered adapter address
- A shared RAM address
- Enable/disable early token release for 16/4 adapters.

IBM PC Network Device Driver Parameters

The two parameters that can be coded with the PC Network device drivers, for the primary and alternate adapter, are:

- A locally administered adapter address
- Work space (internal work area for the adapters).

NETBIOS Device Driver Parameters

The Network Basic Input/Output System (NETBIOS) interface is a message interface used by some application programs to communicate on LANs.

The IBM LAN Support Program provides the option of using "old" or "new" versions of NETBIOS support. The "old" releases of NETBIOS are those available and supported before June, 1985.

One or more new NETBIOS interface device driver parameter keywords may be coded, per adapter. See the *IBM Local Area Network Support Program User's Guide* or the DXMINFO.DOC file for a complete list and definition of these keywords.

These parameters let you customize the NETBIOS device driver for use with network application programs. You may override the defaults on any device driver parameter. Overriding the defaults may provide better performance of bridges, gateways, and servers but increases the memory requirements of the driver. Consult the *User's Guide* provided with each application program for recommended parameter values.

The "new" NETBIOS device driver includes the ENABLE parameter. When you activate ENABLE, there may be some loss in performance. Therefore, activate ENABLE only when the computer contains both a high-speed asynchronous adapter and a LAN adapter.

The IBM PC Network Protocol Driver

The IBM PC Network Protocol Driver supports direct communication on the IBM PC Network Broadband. The driver does not support communication on either the IBM PC Network Baseband or the IBM Token-Ring Network. Refer to the *IBM PC Network Protocol Driver* manual for a complete description of this driver.

When adding new IBM PS/2 computers or PCs to an existing IBM PC Network, the original IBM PC Network Adapter, which uses the resident microcode version of NETBIOS, will NOT communicate with the newer adapters (IBM PC Network Adapter II and IBM PC Network Adapter II/A), which use the IBM LAN Support Program. To enable communication between the original adapter and the newer adapters, install the IBM LAN Support Program in workstations containing the original adapters, or install the IBM PC Network Protocol Driver in workstations containing the newer adapters. The IBM OS/2 Communications Manager also provides functions equivalent to those in the IBM LAN Manager Support Program.

The IBM PC Network Protocol Driver provides an interface equivalent to the NETBIOS interface that exists in the ROM of the original IBM PC Network Adapter.

The newer IBM PC Network adapters do not require the Protocol Driver unless you have a network with both old and new adapters and you want these adapters to be able to communicate with each other.

Workstations that use the IBM PC Network Protocol Driver are **not** compatible with any of the IBM bridging products described in Chapter 15 of this manual.

Installing the Protocol Driver per instructions in the *IBM PC Network Protocol Driver, Version 1.00* manual transfers the `IBMPCNET.SYS` file to the root directory of the default drive, and modifies the `CONFIG.SYS` file by adding `DEVICE=IBMPCNET.SYS`. The Protocol Driver then loads automatically whenever the system is powered on. Using 64 KB of memory, the Protocol Driver supports up to 62 names and 64 sessions.

The IBM 9370 Token-Ring Subsystem Support Program

The IBM 9370 Information System supports direct communication on the IBM Token-Ring Network. The IBM 9370 Information System does not support communication on either the IBM PC Network Broadband or the IBM PC Network Baseband. Refer to the *IBM 9370 Information System: Token-Ring Subsystem Description* for more information about this program.

The IBM 9370 Information System connects to the IBM Token-Ring Network through its Token-Ring Subsystem, which consists of:

- One IBM Communication Processor
- One IBM Token-Ring Network adapter
- One cable (standard adapter cable or Type 3 with a media filter) to connect the IBM Token-Ring Network adapter to an IBM 8228
- The IBM 9370 Token-Ring Subsystem Support Program, which is included in the IBM 9370 microcode.

The IBM 9370 Token-Ring Subsystem requires at least one of the following to be running in the IBM 9370, and can share one network adapter with up to three applications supported by:

- VM/VTAM
- TSAF
- TCP/IP.

Virtual Machine/Virtual Telecommunications Access Method (VM/VTAM) is discussed in more detail on page 12-10.

Transparent Services Access Facility (TSAF) provides communication, messaging, and server functions to users of programs in local or remote virtual machines within a collection of interconnected VM systems.

TSAF provides the following support for each VM system:

- The TSAF virtual machine, which provides the ability to communicate across VM systems
- TSAF program communication services, including an APPC/VM API
- TSAF accounting, session, and link statistics
- TSAF console logging, system dump, system trace, and query functions to aid in TSAF problem diagnosis and resolution.

Transmission Control Protocol/Internet Protocol (TCP/IP) is a set of telecommunication standards used to link different products and systems together. IBM's TCP/IP provides these interconnectivity functions:

- File transfer to remote TCP/IP systems using the File Transfer Program (FTP)
- Electronic mail using the Simple Mail Transfer Protocol (SMTP)
- Remote terminal access to a TCP/IP system using the telephone network.

TCP/IP for VM supports the following:

- IBM Token-Ring Network
- IBM PC Network through the 8232 LAN Channel Station
- Ethernet Network.

IBM TCP/IP for VM running on the IBM 9370 can interconnect other TCP/IP systems and workstations. IBM TCP/IP for VM also has TCP/IP for the PC as an optional feature. This feature allows personal computers to participate in TCP/IP networks through a IBM Token-Ring Network.

The IBM 9370 Token-Ring Network Subsystem must be defined in the IBM 9370 I/O configuration. The definition includes:

- The S/370 or S/390 channel address
- The number of applications sharing the network adapter (1, 2, or 3)
- The universally or locally administered IBM Token-Ring Network adapter address (referred to as the node address)
- Enable or disable the Ring Error Monitor reporting of soft errors on the network.

To the IBM 9370 host software, the Token-Ring Subsystem appears to be and is defined as an IBM 3088 Multisystem Channel Communication Unit connected to a block multiplexor channel. The Token-Ring Network Subsystem supports a maximum of 64 PUs communicating concurrently with the IBM 9370 host computer.

The IBM VTAM and NCP Programs

The IBM Advanced Communication Function/Virtual Telecommunications Access Method (ACF/VTAM* or VTAM*) and the IBM Advanced Communications Function/Network Control Program (ACF/NCP or NCP) provide device and communication support for devices on SNA WANs and LANs. LAN devices communicate with host computers and other devices on WANs through VTAM and NCP.

VTAM and NCP support direct communication on the IBM Token-Ring Network. VTAM and NCP do not support direct communication on the IBM PC Network Broadband or the IBM PC Network Baseband. Refer to the *IBM Network Program Products: General Information: MVS, VM, VSE* for more information about VTAM and NCP.

ACF/VTAM

VTAM is the base for IBM network communications subsystems. VTAM and the IBM 3720, 3725 or 3745 (IBM 37XX) Communications Controller with NCP installed, or the IBM 3174 Establishment Controller with NCP installed, provide functions to handle communications resource sharing and user requests for IBM S/370, IBM 4300, and IBM 9370 host computers.

The key functions, facilities and features of VTAM provide:

- Concurrent execution of multiple telecommunications applications.
- Sharing of telecommunications resources among the programs that reside in the same or in multiple host computers.
- Network management functions under the control of an operator with optional assistance by a programmed operator interface (NCCF or NetView). NetView is a supplementary product that provides in a single package the functions of the Network Communication Control Facility (NCCF), the Network Problem Determination Application (NPDA), the Networking Logical Data Manager (NLDM), and additional functions not found in those products.
- Statistics gathering, dynamic resource sharing, tuning, tracing, and testing facilities.
- With NCP, the capability for transparent interconnection and communication among multiple, independent SNA networks.

For devices connected directly (channel-attached) to a host computer, VTAM controls and manages network communication between a device and the host on both physical and logical levels. If devices communicate with the host through NCP and an IBM 37XX Communications Controller, VTAM leaves much of the physical device management to NCP.

In order to control an SNA resource, the resource must be defined to VTAM, through specifying values for macro definition parameters. The parameters describe to VTAM the physical and logical characteristics of devices, communication lines, network connection points, and communication resources (such as buffers and addresses).

The VTAM parameters significant to LANs include:

Macro	Operand
VBUILD	**TYPE**: Most LAN stations that communicate with an SNA host computer are defined to VTAM as *switched major nodes*. An exception is the IBM 3174 used as a local gateway; it is defined as a *local major node*.
PU	**TYPE**: Most LAN stations are defined to VTAM as Physical Unit Type 2 (usually Type 2.1).
	IDNUM: This parameter identifies a particular station, and usually should match a physical unit ID in application or support program configuration definitions.
	IDBLK: This parameter identifies a device type; particular protocols and applications including APPC and 3270 emulation use specific values.
PATH	**DIALNO**: If the host can initiate (dial) a connection with a LAN workstation and application program, this parameter must include the station's adapter address. The adapter address must be a locally administered address.

Many VTAM definition parameters define communication and device characteristics and the resources required to accomplish communication on the network between attached devices. These parameter definitions must be compatible with:

- Device configuration parameters and application program parameters
- Devices and application programs that communicate with each other and with a host computer.

VTAM macro parameters require definitions for:

- Number and size of data transmit and receive buffers
- Maximum frame and message size that can be handled by a device, a program, a host computer, or a communication line with a particular line data rate
- Data flow control, including pacing, maximum frames transmitted before an acknowledgment is required from the receiver, maximum number of transmission retries before a transmission error or failure is indicated.

ACF/NCP

NCP resides in an IBM 3720, 3725 or 3745 (IBM 37XX) Communication Controller, and provides the physical management of a communication network.

NCP operates in a single host environment or in an environment where it serves multiple local or remote hosts. NCP communicates with the host computer through VTAM, either directly or through another NCP.

The main functions of NCP include:

- Line and terminal control, scheduling, statistics, activation, and deactivation
- Character code translation
- Error detection, recovery, and statistics
- Test and trace facilities
- Data routing through the network.

Macro definition parameters describe to VTAM the physical and logical characteristics of devices, communication lines, network connection points, paths through the network, and communication resources (such as buffers and addresses).

The NCP parameters significant to LANs include:

Macro	Operand
BUILD	**MXRLINE** and **MXVLINE**: These parameters describe the number of physical and logical lines connected to a controller. The values must correspond to the number of physical and logical lines specifically defined in other NCP macros.
LUDRPOOL	**NUMTYP2**: Specifies the number of logical units that can be active concurrently.
GROUP	**(No Specific LAN Parameters)** This macro defines physical lines that can be treated as a logical group. **Autogen** defines logical lines that can be used for expansion without having to redefine NCP.
LINE	**LOCADD**: This parameter defines the locally administered address of the Token-Ring Interface Coupler (TIC) used by NCP to connect to the IBM Token-Ring Network. Each digit in the 12-digit TIC address must be decimal. The TIC address need not be unique on the local area network if this TIC is not active on the same LAN segment as another TIC with the same address.

Many of the NCP definition parameters define communication and device characteristics and the resources required to accomplish communication on the network between attached devices. These parameter definitions must be compatible with:

- Device configuration parameters and application program parameters
- Devices and application programs that communicate with each other and with a host.

NCP macro parameters require definitions for:

- Number and size of data transmit and receive buffers
- Maximum frame and message size that can be handled by a device, a program, a host computer, or a communication line with a particular line data rate
- Data flow control, including pacing, maximum frames transmitted before an acknowledgment is required from the receiver, maximum number of transmission retries before a transmission error or failure is indicated.

The IBM NCP Network Token-Ring Interface (NTRI)

The IBM 3720, 3725, and 3745 Communications Controllers support direct communication on the IBM Token-Ring Network.

The IBM 3720, 3725, and 3745 Communications Controllers do not support direct communication on either the IBM PC Network Broadband or the IBM PC Network Baseband. Communication between these controllers and an IBM PC Network workstation requires installation of the IBM 3270 Emulation Program in the workstation. The Emulation Program translates information from the workstation into a form recognizable by the controller, and translates information from the controller to a form recognizable by the workstation. The physical connection between the workstation and the controller is one that makes the workstation seem to be an IBM 3274 device.

Refer to the *IBM Network Control Program Resource Definition Guide* for a complete description of the NTRI program.

The IBM 3720, 3725, and 3745 Communications Controllers can serve as gateways to SNA host computers by workstations on an IBM Token-Ring Network. The Network Control Program (NCP) that runs in a controller contains the Network Token-Ring Interface (NTRI) function. NTRI provides adapter and interface software support for the Token-Ring Network Attachment Subsystem (TRSS) in a controller.

The TRSS hardware consists of:

- One Token-Ring Multiplexor
- One or more Token-Ring Interface Couplers (TICs), each of which connects to an IBM 8228. Table 12-1 shows the possible configurations of TRAs, TICs, rings, and physical units (PUs).

Table 12-1. IBM Token-Ring Network Connections

Hardware	**3720**	**3725**	**3745**
Token-Ring Adapter (TRA)	1	1 to 2	1 to 4
Token-Ring Interface Coupler (TIC)	1 to 2	1 to 8	1 to 8
Rings	1 to 2	1 to 8	1 to 8
Physical Unit (PU)	1 to 520	1 to 1500	1 to 1500

Each TIC (the physical connection to the IBM Token-Ring Network) is defined to NCP as a leased, full-duplex, point-to-point line. Each PU communication from a LAN Segment to a host through NCP is defined as being connected by a switched, half-duplex, point-to-point line. PU type 4 and 5 session capability allows for NCP-to-NCP communication through an IBM Token-Ring Network and for NCP communication to VTAM in an IBM 9370 host computer.

IBM 3174 Establishment Controller

The IBM Token-Ring Network 3270 Gateway feature supports direct connection to the IBM Token-Ring Network. The IBM Token-Ring Network 3270 Gateway feature does not support connection to either the IBM PC Network Broadband or the IBM PC Network Baseband.

Refer to the following manuals for a complete description of the 3270 Gateway feature:

- *IBM 3174 Establishment Controller Planning Guide*, GA27-3862
- *IBM 3174 Establishment Controller Utilities Guide*, GA27-3863
- *IBM 3174 Establishment Controller Functional Description*, GA23-0218.

An IBM 3174 Establishment Controller can function in three ways on an IBM Token-Ring Network:

- As a Local Gateway

  The IBM 3174 connects directly to the IBM Token-Ring Network and to an SNA host computer. With appropriate programs installed, LAN workstations can communicate through the gateway with the host.

- As a Remote Gateway

  The IBM 3174 connects directly to the IBM Token-Ring Network and connects to an SNA host computer through an IBM 3270, 3725 or 3745 Communications Controller running NCP. With appropriate programs installed, network workstations can communicate through the gateway with the host.

- As a Downstream Physical Unit (DSPU)

  The IBM 3174 connects directly to the IBM Token-Ring Network. The IBM 3174 can communicate with an SNA host computer through another IBM 3174 functioning as a gateway, or through an IBM 3720, 3725 or 3745 Communications Controller.

The IBM 3174 when operating as a local or remote gateway requires the IBM Token-Ring Network 3270 Gateway feature, consisting of:

- An IBM Token-Ring Network adapter
- S-level microcode (supplied on the IBM 3174 Utility/Diagnostic and Control diskettes).

The IBM 3174 when operating as a DSPU requires:

- An IBM Token-Ring Network adapter
- A-level microcode (supplied on the IBM 3174 Utility/Diagnostic and Control diskettes).

The IBM 3174 microcode requires customization for IBM Token-Ring Network support:

- The IBM 3174 should use a locally administered address for the Token-Ring Network adapter. The format depends on the programs that use the gateway. IBM 3270 emulation products require decimal digits only; other products may be able to recognize hexadecimal digits. Devices that use an IBM 3174 gateway must also have locally administered addresses in the format required by the programs that run in them.

- The IBM 3174 supports the Ring Error Monitor (REM) function for reporting network soft errors; REM may be enabled or disabled during customization.
- The IBM 3174 when used as a gateway cannot establish communication with devices on a remote LAN unless it can find the unique address of the remote device. The network administrator must ensure that the IBM 3174 gateway recognizes the address that the remote LAN is using for the remote device.
- The IBM 3174 requires a Link Subsystem Name to identify it in alerts sent to NetView.
- For IBM 3174 gateways and the devices that use them, the channel and control unit addresses specified in the IBM 3174 customization must match those defined for the host Operating System, NCP, and VTAM.
- If the IBM 3174 operating as a DSPU also uses a gateway, the PU identification in the DSPU customization must match the IDNUM value for the DSPU in the VTAM Switched Major Node definition at the host.
- For an IBM 3174 operating as a DSPU, customization includes specification of the maximum frame size exchanged by the DSPU and a gateway and the maximum number of frames sent and received before an acknowledgement is required. Newer IBM 3174 Establishment Controllers negotiate frame size: older 3174s do not.

IBM 3174 Establishment Controller Peer Communications

3174 Peer Communication allows existing DOS-based devices to form a star-wired LAN segment that is bridged to an IBM Token-Ring through the 3174 controller. The IBM 3174 Establishment Controller Peer Communication on 3174 Wiring RPQ 8Q0718 extends the support on your 3174 Establishment Controller to create a 3174-Peer segment, which is analogous to a LAN segment. This feature is in addition to the other functions your controller performs.

3174 Peer Communication provides a way for intelligent devices to:

- Share resources, such as files, databases, application programs, and printers
- Communicate peer-to-peer
- Increase connectivity options
- Retain host connectivity.

3174 Peer Communication supports LAN sessions between:

- Devices attached to the same 3174-Peer controller
- A device attached to the 3174-Peer controller and a device on the Token-Ring
- Devices attached to two different 3174-Peer controllers, if both those controllers are connected to the same Token-Ring network.

3174 Peer Communication provides:

- Local peer-to-peer communication
- Bridge function
- Local management and problem determination functions.

Local Peer-to-Peer Communication

The 3174-Peer RPQ provides peer-to-peer communication among devices connected to a 3174 controller through 3270 Connection Adapters or 3278/3279 Emulation Adapters. 3174 Peer Communication provides an additional communication function for intelligent devices whose current uses are primarily host-interactive communication.

The devices with 3174-WPCSP operate as stations on a single 3174-Peer segment, analogous to a single Token-Ring LAN segment. The 3174-Peer RPQ allows you to run LAN applications.

Bridge Function

The 3174-Peer RPQ allows devices to have access to a Token-Ring network. When the 3174-Peer RPQ is installed, the controller forms a bridge that attaches one 3174-Peer segment to a Token-Ring LAN segment. It operates as a medium access control (MAC) relay station, using source routing as described in the *IBM Token-Ring Network Architecture Reference.*

Because the controller is the only bridge to the 3174-Peer segment, it forwards single-route broadcast frames allowing the 3174-Peer segment to function in a network using spanning tree protocols.

You must have a 3174 Type 3A Dual Speed (16/4) Communications Adapter for the controller to act as a 3174-Peer bridge. You can configure the adapter to attach to a Token-Ring that operates at either 4 or 16 Mbps.

Local Management and Problem Determination Functions

Local management and problem determination functions provide for administration of the 3174-Peer segment formed by a single controller and the devices attached to it. These functions are provided by online tests, which are designed to diagnose and solve problems and to permit changes for configuring your network properly.

IBM System/36 or 38

The IBM System/36 or 38 supports attachment to an IBM Token-Ring Network using the appropriate hardware and software described below. Access to an IBM PC Network Broadband is accomplished through a connection to a network workstation that uses the IBM 3270 Emulation Program. System/36 or 38 does not support attachment to an IBM PC Network Baseband.

Refer to the *System/36 or 38 Local Area Network Attachment Guide to Operations* for a complete description of attaching a System/36 or 38 to a LAN.

Using the S/36 or 38 on an IBM Token-Ring Network

System/36 or 38 attachment to an IBM Token-Ring Network differs with the model of S/36 or 38.

- Two models (5360, 5362) connect to the IBM Token-Ring Network through a separate personal computer (an IBM Personal Computer AT*).

  These models require the System/36 or 38 Attachment Feature. This feature consists of:

  - An IBM Token-Ring Network adapter that uses PC/IO Channel architecture (installed in the IBM Personal Computer AT)
  - A S/36 or 38 Interface Adapter (installed in the IBM Personal Computer AT)
  - A LAN Interface Adapter (installed in the S/36 or 38).

  The System/36 or 38 requires the S/36 or 38 System Support Program (SSP), the S/36 or 38 LAN Communication Program, and the PC Support/36 or 38 Program.

  The IBM Personal Computer AT requires a download of the S/36 or 38 LAN Communication Program.

- One model (5364) connects to the IBM Token-Ring Network through the IBM Personal Computer AT that is used as the S/36 or 38 console.

  The IBM Personal Computer AT used as the S/36 or 38 console, requires an IBM Token-Ring Network adapter that uses PC/IO Channel architecture, the appropriate level of DOS, and a download of the S/36 or 38 LAN Communication Program.

  The System/36 or 38 requires the S/36 or 38 SSP, the S/36 or 38 LAN Communication Program, and the PC Support/36 or 38 Program.

- One model (5363) connects directly to the IBM Token-Ring Network.

  This model requires installation of an IBM Token-Ring Network adapter that uses PC/IO Channel architecture in a S/36 or 38 Processing Unit Expansion Feature. The System/36 or 38 requires the S/36 or 38 SSP, the S/36 or 38 LAN Communication Program, and the PC Support/36 or 38 Program.

Workstations that intend to communicate with the IBM System/36 or 38 must have the PC Support/36 or 38 Program installed.

The S/36 or 38 can serve as a gateway to other networks and hosts. Remote service to other S/36 or 38 units requires Advanced Peer-to-Peer Networking (APPN). IBM Token-Ring Network support cannot be used concurrently with Binary Synchronous Communication (BSC) or Asynchronous Communication support.

The S/36 or 38 will not function as a bridge when two adapters are connected to different IBM Token-Ring Networks. Each adapter can connect to the same IBM Token-Ring Network to provide S/36 or 38 service to twice as many attaching devices, or each adapter can attach to a different network.

The **S/36 or 38 LAN Communication Program** provides a subset of the IBM LAN Support Program. It also provides the following Network Management functions:

- Ring Error Monitor (REM) soft error reports
- Beacon processing
- Error logging and operator notification of hard and soft errors.

The **PC Support/36 or 38 Program** is used by the personal computers that attach directly to the S/36 or 38, and those that attach through a LAN. This program provides information exchange and resource sharing between a personal computer and the S/36 or 38.

Using the S/36 or 38 on an IBM PC Network

The IBM S/36 or 38 does not support direct connection to the IBM PC Network Broadband. Communication between the IBM S/36 or 38 and an IBM PC Network Broadband workstation requires installation of the IBM 3270 Emulation Program in the workstation. The Emulation program translates information from the workstation into a form recognizable by the IBM S/36 or 38, and translates information from the IBM S/36 or 38 to a form recognizable by the workstation. Physical connection between the workstation and the IBM S/36 or 38 is made as though the workstation is an IBM 3274 device.

The IBM S/36 or 38 does not support connection to the IBM PC Network Baseband.

IBM AS/400

The IBM AS/400 supports direct connection to the IBM Token-Ring Network.

The IBM AS/400 does not support direct connection to the IBM PC Network Broadband. Communication between the IBM AS/400 and an IBM PC Network Broadband workstation requires installation of the IBM 3270 Emulation Program in the workstation. The Emulation program translates information from the workstation into a form recognizable by the IBM AS/400, and translates information from the IBM AS/400 to a form recognizable by the workstation. Physical connection between the workstation and the IBM AS/400 is made as though the workstation is an IBM 3274 device.

The IBM AS/400 does not support connection to the IBM PC Network Baseband.

Refer to the *IBM AS/400 Communications: 3270 Device Emulation User's Guide* for a complete description of attaching an AS/400 to a LAN.

The IBM AS/400 attaches directly to the IBM Token-Ring Network using an integrated Token-Ring Network adapter attached by cable to an access unit, such as an IBM 8228. Two adapters may be installed in an AS/400. Adapters may be factory installed, or field installed by an IBM Customer Engineer. Each adapter supports up to 256 active connections to workstations on the ring.

Workstations sharing the same IBM Token-Ring Network as an IBM AS/400 can communicate through this AS/400 with other AS/400s, S/36 or 38s, or through a gateway to an SNA host computer. The IBM AS/400 requires the AS/400 System Support Program (AS/400 SSP) and the AS/400 PC Support Program. Workstations that intend to communicate with the IBM AS/400 must have the AS/400 PC Support Program installed.

- The AS/400 SSP program contains all necessary software to control the IBM Token-Ring adapter.
- The AS/400 PC Support program and the IBM PC LAN Program may run concurrently in a single workstation. The AS/400 PC Support program requires initialization parameters, including ASCII/EBCDIC translate table code page names.

IBM Series/1

The IBM Series/1 supports direct connection to the IBM Token-Ring Network. The IBM Series/1 does not support connection to either the IBM PC Network Broadband or the IBM PC Network Baseband. Refer to the *IBM Series/1 Digest* for a complete description of attaching a Series/1 to a LAN.

The IBM Series/1 can be equipped with a number of attachment features that allow connection to host computers, X.25 networks, and LANs. Each attachment feature requires programming support, which differs according to the operating system used in the Series/1.

The **Series/1 Token-Ring Interface Program** is used with the IBM Series/1-to-Personal Computer Channel Attachment feature. The Interface Program complements the IBM PC LAN Program, giving workstations on an IBM Token-Ring Network access to Series/1 disks and printers.

A LAN-attached Series/1 supports the following services:

- File server — emulation of multiple 32 MB personal computer disks on a Series/1. Data stored on a Series/1 may come from the workstation, Series/1, or a host system.
- Print server — allows LAN-attached workstations access to Series/1 printers.
- Communications server — permits Series/1s to get access to host computers or other Series/1s in a variety of communications environments by using the IBM PC 3270 Emulation Program to communicate through the network.
- Program-to-program communications — supports program-to-program communication between personal computers on the same or separate LAN segments, as well as between Series/1s and personal computers.
- Remote Management Services — enables using host-based network management products.

The Series/1 Token-Ring Interface Program supports the Series/1 Event Driven Executive (EDX) operating system. The Interface Program does not support the Series/1 Realtime Programming System (RPS) operating system.

A Series/1 using the Event Driven Executive operating system must also have the optional Communications Facility Program to manage the flow of information throughout a configuration that may include Series/1s, host computers, personal computers, terminals, and printers.

The IBM LAN Channel Support Program

The IBM LAN Channel Support Program (IBM 8232 Support Program) supports direct communication on either the IBM Token-Ring Network or the IBM PC Network Broadband. This program also supports direct communication on the Ethernet LAN. The IBM 8232 Support Program does not support communication on the IBM PC Network Baseband. Refer to the *IBM LAN Channel Support Program User's Guide* for a complete description of this program.

The IBM LAN Channel Support Program runs on the IBM 8232 LAN Channel Station (IBM 8232), enabling it to establish communication between a host computer and devices on any of the following LANs:

- IBM Token-Ring Network
- IBM PC Network Broadband
- Ethernet Network.

The host computer and LAN devices communicate using the TCP/IP protocol. The IBM 8232 provides a connection between a host computer and up to four LANs, depending on the model used.

To install the IBM 8232 Support Program, you need the following additional software:

- IBM Personal Computer Disk Operating System Version 3.3 or later
- IBM Local Area Network Support Program Version 1.0 or later, if you are using the IBM Token-Ring Network PC Adapter II or the IBM PC Network Adapter II in the IBM 8232.

To install the IBM 8232 Support Program, you must define the IBM 8232 configuration. The program's Configuration Aid prompts you for information about the hosts, the LANs, and the network adapters in the IBM 8232. When the IBM 8232 Support Program is loaded, it generates information messages and error messages. You may issue commands to monitor or modify some of the operating parameters of the IBM 8232 or to request information about the LAN adapters and channel adapter installed in the IBM 8232.

The IBM 3172 Interconnect Controller Program

The IBM 3172 Interconnect Controller Program runs on the IBM 3172 Interconnect Controller, enabling communication between a host computer and any of the following LANs:

- IBM 4-Mbps Token-Ring Networks
- IBM 16-Mbps Token-Ring Networks
- Ethernet Network
- Manufacturing Automation Protocol (MAP) Network 3.0.

The host computer and LAN devices communicate using one of the following:

- TCP/IP protocol
- Advanced Interactive Executive 370 (AIX/370)
- OSI Manufacturing Messaging Services for VM (OSI/MMS for VM).

The IBM 3172 Interconnect Controller Program provides a connection between a host computer and up to four LANs, depending on the model used.

To install the IBM 3172 Interconnect Program, you need the following additional software:

- IBM Personal Computer Disk Operating System Version 3.3 or later, or the DOS mode of OS/2
- IBM 3172 On-line Tests and documentation.

To install the IBM 3172 Interconnect Program, you must modify the host operating system and configure the IBM 3172. The *IBM Interconnect Controller Program Version 1.0 User's Guide* contains two configuration worksheets:

- IBM 3172 Configuration Worksheet
- MAP Adapter Configuration Worksheet.

You must complete the IBM 3172 Configuration Worksheet to use the IBM 3172 Controller Program. Complete the MAP Adapter Configuration Worksheet only if you are using the MAP Network. These worksheets, when completed, contain the detailed information needed to enable the IBM 3172 to recognize and work with the specific LANs and host computer to which it attaches.

Remote Program Load

The IBM Remote Program Load product enhances connection to either the IBM Token-Ring Network, the IBM PC Network Broadband, or the IBM PC Network Baseband. Refer to the *IBM Token-Ring Network Remote Program Load User's Guide* for a complete description of the remote program loading function.

Remote Program Load (RPL) provides the capability to load programs into one workstation from another workstation on the network, without using a disk or diskette drive on the receiving workstation.

The devices that participate in the RPL process are:

Requesting Device
The workstation with its adapter RPL function enabled is called the Requesting Device. The Requesting Device does not need a disk or diskette drive, but needs a display to show the status of the RPL process.

Each time the Requesting Device is restarted, it enables RPL and sends a request to a Loading Device for the programs it needs.

Loading Device
The workstation from which the programs originate is called the Loading Device. The Loading Device must have a fixed disk or diskette drive, but does not require RPL to be enabled on its adapter.

Linking Device
The workstation that sets up the connection between the Requesting Device and the Loading Device is called the Linking Device. The difference between the Loading Device and the Linking Device is only logical. Physically, the Loading Device and the Linking Device may reside in the same workstation or in separate workstations.

All Linking Devices use the adapter functional address X'C000 4000 0000'. A Requesting Device sends its initial RPL requests to this address. The Linking Device determines which Loading Device to link to the Requesting Device.

The user must write two programs for the RPL function:

- The Bootstrap Program

  The Requesting Device receives the Bootstrap Program from the Loading Device as a disk image. The Bootstrap Program is loaded into the memory of the Requesting Device, and restarts the Requesting Device after the disk image has been received. The disk image may also contain:

  - An operating system for the Requesting Device
  - Additional programs that are started by the operating system
  - Adapter support code required by application programs in the image
  - A program that can request more programs or files from the Loading Device.

- The Loader Program

  The Loader Program resides in the Loading Device, and sends the disk image containing the Bootstrap Program to the Requesting Device in response to the request. The IBM PC LAN Program contains aids that help you write a Loader Program.

RPL on the IBM Token-Ring Network

The RPL function resides in a ROM hardware module on the network adapter. The RPL hardware module must be installed by the user on IBM Token-Ring Network adapters in Requesting Devices. (Loading Devices do not require the module.) The module contains:

- A set of commands that locate a Loading Device and request the Bootstrap Program
- Adapter support code to
  - Allow the adapter in the Requesting Device to attach to the network in order to receive the Bootstrap Program
  - Handle some adapter hardware configuration options
- A Disk Emulator that handles the disk image received from the Loading Device as though it were really a file on disk instead of the image in memory.

The adapters use an IEEE 802.2 LLC frame format for transmission of requests and load responses in RPL frames on the network. Adapter commands used for RPL, RPL frame formats, and instructions for writing the RPL programs are described in the *IBM Token-Ring Network Remote Program Load User's Guide*. For more information about commands and frame formats, see also:

- *IBM Local Area Network Technical Reference*
- *IBM Token-Ring Network Architecture Reference*.

RPL on the IBM PC Network

The RPL function resides in a ROM hardware module placed on the network adapter during manufacturing. The module contains the adapter commands used by the Requesting Device to locate the Loading Device and request the disk image.

For the IBM PC Network, the Bootstrap Program must contain code to handle the disk image as though it were a real disk or diskette file.

The adapters use an IEEE 802.2 LLC frame format for transmission of requests and load responses in RPL frames on the network. Adapter commands used for RPL, RPL frame formats, and instructions for writing the RPL programs are described in the *IBM PC Network Adapters Technical Reference*. For more information about commands and frame formats, see the *IBM Local Area Network Technical Reference*.

RPL protocols for the IBM PC Network Adapter (the first IBM PC Network adapter on the market) are not compatible with the RPL protocols for any of the other IBM PC Network adapters.

Chapter 13. Diagnostics and Performance

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The IBM Token-Ring Network Ring Diagnostic

The IBM Token-Ring Network Ring Diagnostic is specifically designed to:

- Collect and analyze data from error reporting frames on a single ring
- Display information about the operation of the ring
- Display information to aid in problem determination.

The Ring Diagnostic includes functions to:

- Test the ability of the ring to transmit data
- Print Ring Diagnostic output as it is displayed on the computer screen
- Write to a formatted diskette the parts of computer memory used by the Ring Diagnostic and its data and control buffers (for your service supplier) if the Ring Diagnostic cannot continue processing.

The Ring Diagnostic runs in an IBM workstation (except the IBM RT PC) attached to an IBM Token-Ring Network segment. The Ring Diagnostic is supplied on the diskette that accompanies each IBM Token-Ring Network adapter. Each adapter diskette has one of three possible formats:

1 The adapter diskette contains adapter diagnostic code, the Ring Diagnostic, and the adapter support code required by the Ring Diagnostic (TOKREUI.COM).

  There are two versions of this diskette format; one for adapters used in computers with PC/IO Channel architecture and one for adapters used in computers with Micro Channel architecture. To use the Ring Diagnostic from either version of a diskette in this format, you must:

  - Copy the Ring Diagnostic and the adapter support code to a formatted diskette
  - Start DOS in the computer
  - Load the adapter support code
  - Load the Ring Diagnostic, with no other programs running in the computer (except DOS and the adapter support code).

  Both versions of the diskette in this format require that you load DOS separately in the computer, then load the adapter support code, and then the Ring Diagnostic. The two versions differ in the use of the adapter diagnostics:

  - To use the adapter diagnostics on the PC/IO Channel architecture version, you insert the diskette into drive A and restart the computer.
  - To use the adapter diagnostics on the Micro Channel architecture version, you must copy the adapter option modules to the computer's Reference Diskette and use Reference Diskette functions to run the adapter system tests.

2 The diskette contains a version of DOS, adapter diagnostics, the Ring Diagnostic, and the adapter support code required by the Ring Diagnostic. This format is only for adapters installed in computers with PC/IO Channel architecture.

   To use the Ring Diagnostic on a diskette in this format, you insert the diskette into drive A and restart the computer. The version of DOS on the diskette loads, and presents a menu that allows you to select and run either the adapter diagnostics or the Ring Diagnostic (with the required adapter support code).

3 The diskette contains a version of DOS, adapter option modules, the Ring Diagnostic, and the adapter support code required by the Ring Diagnostic. This format is only for adapters installed in computers with Micro Channel architecture.

   To use the Ring Diagnostic on a diskette in this format, you insert the diskette into drive A and restart the computer. The version of DOS on the diskette is loaded; it loads the required adapter support code and the Ring Diagnostic. (To use the adapter diagnostics, you must copy the adapter option modules to the computer's Reference Diskette and use Reference Diskette functions to run the adapter diagnostics.)

The diskettes that include the required level of DOS to run the Ring Diagnostic can be used on LAN segments in which the stations run only OS/2 EE. A separate version of DOS is not required just to run the Ring Diagnostic.

The *IBM Token-Ring Network Problem Determination Guide* describes how to start and use the Ring Diagnostic and how to interpret the output.

Ring Diagnostic Output

The Ring Diagnostic supplies information in three categories, each of which is displayed in a separate area of the computer screen.

Ring Status: This indicates a variety of conditions of the ring:

Normal: The Ring Diagnostic is processing information, and the ring is operating normally.

Adapter Closed: This IBM Token-Ring Network adapter is no longer logically attached to the ring.

Soft Error: The ring is experiencing intermittent failures that cause data to be transmitted on the ring more than once to be received correctly. The Ring Diagnostic shows the adapter addresses for the first and second adapters involved in a soft error condition.

Wire Fault: There is a problem with the lobe between the attaching device and the access unit to which it is connected.

Beaconing: The ring is inoperative; the cause could be a broken wire or a faulty adapter. When the problem is isolated to one adapter, its adapter address is displayed to the operator in the data message area.

Ring Diagnostic Status: This indicates the functional status of the Ring Diagnostic itself. Messages displayed in this area of the screen indicate:

- The function the Ring Diagnostic is performing
- The status of the printer
- Display and printer data buffer capacity
- Any Ring Diagnostic error conditions.

Data Area Messages: This is detailed information used partly to find a problem on the ring, and partly for your service supplier if you are unable to resolve the problem. These messages provide additional information about the functioning of the ring, of the Ring Diagnostic, and of the network adapter in the workstation that is running the Ring Diagnostic. As the status of the ring changes, data area messages are generated.

Additional explanations of some of the data area message information are in the *IBM Local Area Network Technical Reference* and in the *IBM Token-Ring Network Architecture Reference* (although the additional material is not required to complete the problem determination procedures).

Bridge Performance Analysis

The following IBM bridging products collect and provide bridge performance information to help you evaluate and manage traffic flowing through a bridge:

- IBM Token-Ring Network Bridge Program, Version 2.2
- IBM Token-Ring Network Bridge Program, Version 2.1
- IBM Token-Ring Network Bridge Program, Version 2.0
- IBM Token-Ring Network Bridge Program, Version 1.1
- IBM PC Network Bridge Program, Version 1.0
- IBM 8209 LAN Bridge.

You can display bridge program performance information at a bridge station. You can also display bridge program performance information, and the IBM 8209 LAN Bridge performance information, at an IBM LAN Manager or IBM LAN Network Manager station. The IBM LAN Manager, Versions 1.0 and 2.0, can establish communication links with some or all of the bridges in your network (depending on the LAN Manager version and the bridge program that are used). Over the links, the IBM bridge products can send bridge status and performance information to the IBM LAN Manager.

Notes:

1. In these discussions, a reference to the IBM LAN Manager without a version number applies to both Versions 1.0 and 2.0. The version number follows the program name when the reference applies only to a particular version (for example, IBM LAN Manager Version 2.0).
2. References to the remote bridge function apply only to the IBM Token-Ring Network Bridge Program, Versions 2.1 and 2.2. The local bridge function of the IBM Token-Ring Network Bridge Program, Versions 2.1 and 2.2, and the other bridging products provide equivalent Token-Ring Network functions (except where specifically noted by version).

See Chapter 15 for more information about communication between bridging products and the IBM LAN Manager or the IBM LAN Network Manager.

The bridges keep performance counters and statistics to help you evaluate and manage traffic through each bridge.

Performance Counters
The bridge performance counters:

- Accumulate numbers of bytes and frames forwarded and not forwarded from each LAN segment to the other through a bridge
- Can be displayed at the bridge station (except for the IBM 8209), the IBM LAN Manager station, or the LAN Network Manager station (for all the bridges listed above)
- Can be recorded by the IBM LAN Manager Version 2.0 in a counter file or by the IBM LAN Network Manager in the Bridge Performance Table on the fixed disk (for all bridges listed above, except the IBM Token-Ring Network Bridge Program, Version 1.1).

  Note: Some of the bridge values in this chapter do not apply to the IBM 8209 LAN Bridge. For more information please refer to your IBM 8209 documentation.

Performance Statistics

The bridge programs (and the IBM LAN Manager or LAN Network Manager for the IBM 8209):

- Allow the user to specify the **Bridge performance threshold** configuration parameter value (maximum number of frames not forwarded per 10,000 frames arriving at the bridge, before a "threshold exceeded" statistic is generated)
- Allow users of the remote bridge function to specify the **Telecommunications link error threshold** configuration parameter value (maximum number of frames not forwarded per 10,000 frames arriving at the bridge, due to errors on the telecommunications link between the two remote bridge stations, before a "threshold exceeded" statistic is generated)
- Display the number of times that the **Bridge performance threshold**, or the **Telecommunications link error threshold** for the remote bridge function, is exceeded within each 5 minutes of a 24-hour period
- Send a performance notification to network manager programs each time the **Bridge performance threshold**, or the **Telecommunications link error threshold** for the remote bridge function, is exceeded.

Bridge Performance Counters

The bridges maintain several counters for each LAN segment connected to a bridge. The counters record the following:

Broadcast frames forwarded
This counter contains the number of broadcast and single-route broadcast frames successfully forwarded by the bridge program:

- From one LAN segment to the other, for a bridge that uses local bridge function
- From one half of a bridge that uses the remote bridge function onto the telecommunications link that connects the two bridge halves.

Broadcast bytes forwarded
This counter contains the number of broadcast and single-route broadcast bytes successfully forwarded by the bridge program:

- From one LAN segment to the other, for a bridge that uses local bridge function
- From one half of a bridge that uses the remote bridge function onto the telecommunications link that connects the two bridge halves.

Not all of the bytes in each frame are counted. The bytes counted for each frame are those between and included in the Access Control Field and the Information Field (see the frame format in Figure 13-1 on page 13-12).

Non-broadcast frames forwarded
This counter contains the number of non-broadcast frames successfully forwarded by the bridge program:

- From one LAN segment to the other, for a bridge that uses local bridge function
- From one half of a bridge that uses the remote bridge function onto the telecommunications link that connects the two bridge halves.

Non-broadcast bytes forwarded
This counter contains the number of non-broadcast bytes successfully forwarded by the bridge program:

- From one LAN segment to the other, for a bridge that uses local bridge function
- From one half of a bridge that uses the remote bridge function onto the telecommunications link that connects the two bridge halves.

Not all of the bytes in each frame are counted:

- For bridges connecting two rings, the bytes counted for each frame are those between and included in the Access Control Field and the Frame Check Sequence (see the frame format in Figure 13-1 on page 13-12).
- For bridges connecting one IBM PC Network Bus and one ring or two IBM PC Network Buses, the bytes counted for each frame are those between and included in the Access Control Field and the Information Field (see the frame format in Figure 13-1 on page 13-12).

Frames not forwarded; target LAN segment inoperative

- For a target ring:

  This counter contains the number of frames not forwarded by the bridge because the frames arrived during a period when the target ring was beaconing. The count also includes frames waiting at the bridge to be forwarded when the ring began beaconing; these frames are also not forwarded.

- For a target IBM PC Network Bus:

  This counter contains the number of frames not forwarded by the bridge because the frames arrived during a period when the target IBM PC Network Bus was in a continuous-carrier condition or a no-carrier condition. The count also includes frames that the bridge discarded after experiencing 16 consecutive collisions in attempting to forward the frames to the target IBM PC Network Bus.

Frames not forwarded; adapter congestion

This counter contains the number of frames not forwarded because:

- Frames are arriving at the bridge from the source LAN segment faster than the bridge program can process them and forward them to the destination LAN segment or to the remote bridge telecommunications link.
- The destination LAN segment is too busy to accept frames as fast as the bridge program is processing and forwarding them.
- The remote bridge telecommunications link cannot accept frames as fast as the bridge program is processing and forwarding them.

For the IBM Token-Ring Network, this counter contains the number of frames intended to be forwarded across this bridge but were not forwarded due to adapter congestion.

For the IBM PC Network, this counter contains the total number of frames arriving at a bridge adapter that is experiencing adapter congestion. (When an adapter is not experiencing congestion, frames arriving at the adapter but not intended (by routing information) to be forwarded across the bridge are counted in the "Frames not routed across this bridge" counter.)

Frames not forwarded; telecommunications link error

This counter is used only for the remote bridge function. This counter contains the number of frames sent onto the telecommunications link by one bridge half, but not received by the other bridge half due to errors on the telecommunications link connecting the two stations.

Bytes not forwarded; telecommunications link error

This counter is used only for the remote bridge function. This counter contains the number of bytes sent onto the telecommunications link by one bridge half, but not received by the other bridge half due to errors on the telecommunications link connecting the two stations.

Note: This counter is displayed only on the Bridge Program Performance Counters panel at a bridge using the remote bridge function. This counter is sent to the IBM LAN Manager Version 2.0 only for recording in the counter file data records.

Frames not forwarded; filtered

This counter is used only by the IBM Token-Ring Network Bridge Program Version 2.1 or 2.2. This counter contains the number of frames discarded due to filtering. Filtering is provided by a program that selects only certain frames to be forwarded across a bridge using the IBM Token-Ring Network Bridge Program Version 2.1 or 2.2. You might use filtering to limit traffic across a remote bridge telecommunications link, or to provide network security by limiting access to a bridge.

Note: This counter appears only on the Bridge Program Performance Counters panel at a bridge using the IBM Token-Ring Network Bridge Program Version 2.1 or 2.2. This counter is not sent to the IBM LAN Manager. This counter is logged, but not displayed at the IBM LAN Network Manager.

Frames not forwarded; other reasons

This counter contains the number of frames not forwarded due to invalid frame lengths or invalid frame Routing Information (RI) fields. The causes for invalid frames include:

- The malfunctioning of an IBM network adapter that sends frames across the bridge
- The presence of a non-IBM adapter on the network, which is either malfunctioning or sending frames to the bridge that do not meet IBM network requirements
- The setting of the maximum frame size in network device or application program configurations that is larger than the maximum frame size that the bridge can process.

The specific occurrences counted are:

- Frame length is less than the minimum allowed on the network.
  - Minimum broadcast frame = 20 bytes
  - Minimum non-broadcast frame = 22 bytes
- Frame length exceeds the maximum allowed to cross a bridge.
  - Maximum frame sizes for bridges using local bridge function (one bridge computer containing two bridge adapters)

    The largest frame size allowed to cross the bridge varies depending on the types of adapters used for the primary and alternate bridge adapters. The largest frame size that can cross a bridge in either direction is the smaller of the two bridge adapter maximum frame sizes, which are shown in Table 13-1 on page 13-11. The maximum frame size cannot be changed in the bridge program configuration for a bridge that uses local bridge function.

Table 13-1. Maximum Frame Size Default Values for Local Bridge Function	
Adapters	**Largest Frame Size**
IBM Token-Ring Network 16/4-Mbps adapters at 16 Mbps	8144 bytes
IBM Token-Ring Network 16/4-Mbps adapters at 4 Mbps	4472 bytes
IBM Token-Ring Network 4-Mbps adapters	2052 bytes
IBM PC Network adapters	2052 bytes

– Remote bridge function maximum frame sizes

The largest frame size that can cross a bridge that is using the remote bridge function depends on the line data rate of the telecommunications link connecting the two halves of the bridge. The Bridge Program discards frames larger than the specified maximum frame size.

Table 13-2. Recommended Maximum Frame Size Default Values for the Remote Bridge Function	
Line Data Rate	**Recommended Largest Frame Size**
9.6 Kbps $\leq$ D $<$ 38.4 Kbps	516 bytes
38.4 Kbps $\leq$ D $<$ 56 Kbps	1500 bytes
56 Kbps $\leq$ D $\leq$ 1.344 Mbps	2052 bytes
Note: D = Line Data Rate	

You may override the default value for the largest frame size parameter in the bridge program configuration. See "Bridge Program (Version 2.1) Configuration Parameters" on page 15-41 for information about changing the maximum frame size parameter value.

- RI field is invalid
  - Source LAN segment number is in the RI field, but is not last (broadcast frames only)
  - Duplicate LAN segment numbers in the RI field (non-broadcast frames only)
  - Source LAN segment number is not in the RI field (broadcast frames only)
  - Destination ring number is not in the RI field (IBM Token-Ring Network non-broadcast frames only).

Frames not routed across this bridge

This counter is used only by the IBM PC Network Bridge Program. This counter contains the number of frames received by an IBM PC Network bridge that did not contain the LAN segment number and bridge number for this bridge in the frame Routing Information field.

This counter accumulates frames passed to the bridge program only while the IBM PC Network bridge adapter is not experiencing adapter congestion. When an IBM PC Network bridge adapter experiences congestion, the number of frames that arrived at the adapter but could not be passed to the bridge program are counted in the "Frames not forwarded; adapter congestion" counter.

This counter is used in analysis calculations that include the total number of frames received at an IBM PC Network bridge adapter.

Note: The "Frames not routed across this bridge" counter appears only on the Bridge Program Performance Counters panel at a bridge using the IBM PC Network Bridge Program.

SD	AC	FC	Dest. Addr.	Source Addr.	Rout.	Info. Field	FCS	ED	FS
1 Byte	1 Byte	1 Byte	6 Bytes	6 Bytes	0-18 Bytes		4 Bytes	1 Byte	1 Byte

Figure 13-1. Frame Format

The abbreviations used in the frame format are:

SD	Starting Delimiter
AC	Access Control Field
FC	Frame Control Field
FCS	Frame Sequence Check
ED	Ending Delimiter
FS	Frame Status Field.

Each bridge program maintains three copies of the performance counters:

1. The bridge programs use one copy of the counters to display the current values of the counters on the Bridge Program Performance Counters panel.

   The user can press a function key and set this copy of the counters to zeros before accumulating counter values over a time period for a bridge performance analysis. If these counters reach the maximum values that they can contain (overflow), the counters roll over to zeros and counting continues. When any of the counters roll over, the bridge programs display a message indicating that the counters have overflowed.

2. The Bridge Program Performance Statistics function uses a second copy of the counters to determine, at 1-minute intervals, whether the **Bridge performance threshold** or the **Telecommunications link error threshold** (for the remote bridge function) has been exceeded.

If the counts reach the maximum values that these counters can contain, they are not incremented again until they are reset to zeros when the next 1-minute measurement interval begins.

Notes:

a. The total number of frames arriving at the bridge and the total number of frames in error (excluding telecommunications link errors) are used for the remote bridge function to determine if the Bridge performance threshold has been exceeded. The count of frames filtered is included in the total number of frames arriving at the bridge, but is not included in the total number of frames in error (excluding telecommunications link errors).

b. Because filtered frames are not sent onto the telecommunications link and therefore cannot be lost due to telecommunications link errors, they are not included in the "threshold exceeded" calculation for the Telecommunications link error threshold.

3 The third copy of the counters is used to respond to network manager program requests to receive the current counter values from the bridge programs. A network manager program (such as the IBM LAN Manager) can establish a communication link with a bridge program, and request to receive the counter values over the link from the bridge program. The IBM LAN Manager provides functions to:

- Request and display the current counter values
- Record the counter values in a disk file each time a specified time interval elapses (IBM LAN Manager Version 2.0 only).

If the counts reach the maximum values that these counters can contain, the counters roll over to zeros and counting continues. These counters are reset to zeros when the bridge programs are restarted, but cannot be reset by the user. This allows more than one network manager program to obtain the same counter information from a bridge.

Note: The "Frames not forwarded; filtered" counter (IBM Token-Ring Network Bridge Program Version 2.1 or Version 2.2) and the "Frames not routed across this bridge" counter (IBM PC Network Bridge Program) are not sent to network manager programs.

Table 13-3 on page 13-14 shows the counter lengths and maximum values for the IBM Token-Ring Network Bridge Program Version 2.0, the IBM Token-Ring Network Bridge Program Version 2.1 or Version 2.2, and for the IBM PC Network Bridge Program.

Table 13-4 on page 13-14 shows the counter lengths and maximum values for the IBM Token-Ring Network Bridge Program, Version 1.1.

Table 13-3. Performance Counters. IBM Token-Ring Network Bridge Program Versions 2.0, 2.1, and 2.2		
Counter	**Length in Bytes**	**Maximum Value**
Broadcast frames forwarded	4	4,294,967,295
Broadcast bytes forwarded	6	281,474,976,710,655
Non-broadcast frames forwarded	4	4,294,967,295
Non-broadcast bytes forwarded	6	281,474,976,710,655
Frames not forwarded; target LAN segment inoperative	4	4,294,967,295
Frames not forwarded; adapter congestion	4	4,294,967,295
Frames not forwarded; telecommunications link error	4	4,294,967,295
Bytes not forwarded; telecommunications link error	6	281,474,976,710,655
Frames not forwarded; filtered	4	4,294,967,295
Frames not forwarded; other reasons	4	4,294,967,295

Table 13-4. Performance Counters. IBM Token-Ring Network Bridge Program, Version 1.1, IBM PC Network Bridge Program		
Counter	**Length in Bytes**	**Maximum Value**
Broadcast frames forwarded	4	4,294,967,295
Broadcast bytes forwarded	6	281,474,976,710,655
Non-broadcast frames forwarded	4	4,294,967,295
Non-broadcast bytes forwarded	6	281,474,976,710,655
Frames not forwarded; target ring inoperative	2	65,535
Frames not forwarded; adapter congestion	2	65,535
Frames not forwarded; other reasons	2	65,535
Frames not routed across this bridge (PC Network Bridge Program only)	4	4,294,967,295

The performance counter names used on the bridge program panels and IBM LAN Manager panels are not the same names used to describe these counters in the *IBM Token-Ring Network Architecture Reference*. Table 13-5 shows the names for the counters used on the panels and the corresponding names used in the *Architecture Reference*.

Table 13-5. Performance Counter Names

Counter Names Used on Bridge and LAN Manager Panels	**Counter Names Used in Architecture Reference**
Frames not forwarded; target LAN segment inoperative	Frames discarded
Frames not forwarded; adapter congestion	Frames not received
Frames not forwarded; telecommunications link error	Frames discarded; internal errors
Bytes not forwarded; telecommunications link error	Bytes discarded; internal errors
Frames not forwarded; filtered	Frames filtered at bridge
Frames not forwarded; other reasons	Frames not forwarded
Frames not routed across this bridge	Frames not routed across bridge

Bridge Program Performance Statistics

The Bridge Program Performance Statistics provide an indication that frames are not being forwarded through the bridge. The bridge is operating under a condition that may be detrimental to end user performance. Such conditions include:

- The occurrence of a high rate of invalid frames from a defective network station
- A momentary bridge overload due to fluctuations in the traffic through the bridge or on the destination (target) LAN segment
- Errors on the telecommunications link connecting the two stations of a bridge using the remote bridge function.

Bridge Performance Thresholds

Workloads on the network and the requirements of end users and application programs vary widely. Some end users and application programs may be able to detect that 1 frame out of 1,000 was not forwarded through the bridge; others (because of different workloads and performance requirements) will function if no more than 1 frame out of 100 is not forwarded.

The bridge programs provide a **Bridge performance threshold** parameter that allows you to indicate the maximum ratio of frames not forwarded to frames arriving at a bridge that is acceptable to the users and applications that send and receive data across the bridge.

You should adjust the **Bridge performance threshold** value for each bridge in your network over time to provide better correlation between the occurrence of a threshold being exceeded and the end user being able to perceive a problem in response time, data exchange, or application program operation.

Bridges that provide the remote bridge function also provide the **Telecommunications link error threshold** parameter. This parameter allows you to specify the maximum number of frames, per 10,000 forwarded onto the telecommunications link, not received by the other bridge half due to telecommunications link errors.

The bridge programs check the performance counters once each minute to see whether a threshold has been exceeded. (Both thresholds are checked for a bridge that uses the remote bridge function.) Each time a threshold has been exceeded, the bridge programs count a "threshold exceeded" occurrence in the Performance Statistics. The bridge programs display on the Performance Statistics panel the number of times a threshold has been exceeded in each 5-minute interval of a 24-hour period.

Bridge Performance Threshold
The **Bridge performance threshold** configuration parameter value specifies the maximum number of frames per 10,000 frames arriving at the bridge that are not forwarded (for all reasons except filtering, remote bridge telecommunications link errors, and frames not routed across this bridge) to the other LAN segment before the bridge program counts a "threshold exceeded" occurrence in the Performance Statistics. For most bridges, the **Bridge performance threshold** default value of 10 frames not forwarded per 10,000 frames arriving at the bridge should be acceptable.

See "Bridge Performance Considerations" on page 13-36 for information about adjusting the **Bridge performance threshold** value.

Telecommunications Link Error Threshold
The **Telecommunications link error threshold** configuration parameter specifies the maximum allowable number of frames, per 10,000 forwarded from one side of the bridge onto the telecommunications link, that were not received by the other side of the bridge due to errors on the telecommunications link connecting the two halves of a bridge. Each time the threshold is exceeded, the Bridge Program counts a "threshold exceeded" occurrence in the Performance Statistics. The Bridge Program also sends a notification to any network manager programs with which a link is established.

The default telecommunications link error threshold values shown in Table 13-6 on page 13-19 are largely based on the expected number of frames lost for a particular telecommunications environment. The values were determined from calculations based on the following:

- Line data rate of the telecommunications link between the two bridge stations
- A telecommunications link quality of 67% error-free seconds along with the corresponding bit-error rate
- Maximum average frame size that crosses the telecommunications link.

  This value is the higher of the two frame size averages, one taken from each of the two directions across the bridge.

Default values may be changed to better suit a user's requirements. You can use the formulas on page 13-18 to determine the threshold value to use instead of a default value.

There are several ways to determine the telecommunications link error threshold value to specify when you are creating the configuration file for a bridge using the remote bridge function:

- You can let the Bridge Program use the default value shown in Table 13-6 on page 13-19 for the line data rate of your telecommunications link.

  You may need to run your bridge with a default threshold value at first, observe its operation, and use the bridge performance information (actual counts of frames and bytes forwarded across the bridge) to obtain a maximum average frame size and a more accurate threshold value.

  To obtain the maximum average frame size for a bridge:

  1 Run the bridge for approximately 24 hours.

     a. Observe bridge operation.

     b. Record performance counter values at intervals no shorter than 15 minutes.

c. Use the frames and bytes forwarded counter values for each interval and for each LAN segment to calculate the average frame size in bytes that was forwarded from each LAN segment during the interval:

$$\text{Average} = \frac{(\text{Broadcast bytes forwarded}) + (\text{Non} - \text{broadcast bytes forwarded})}{(\text{Broadcast frames forwarded}) + (\text{Non} - \text{broadcast frames forwarded})}$$

d. The maximum average frame size for the bridge is the largest average frame size you calculated, from any interval on either LAN segment.

2 Table 13-7 on page 13-19 shows threshold values that can be used for approximate average frame sizes over telecommunications links of several different line data rates.

After you have run the bridge with a default threshold value and obtained a maximum average frame size, you can choose an appropriate threshold value for your bridge from the table.

3 You can use a formula to estimate the **Telecommunications link error threshold** value for a given maximum average frame size.

The formula uses the following variables:

P_b = The expected bit-error rate of the telecommunications link between the remote bridge stations.

For a line quality expressed in percentage of error-free seconds (a common way that link carriers specify quality), you can use the following calculation to obtain P_b:

$P_b = 1 - \sqrt[R]{(.01 \times E)}$

The variables used in the calculation are:

E = Error-free seconds (for 67% error-free seconds, for example, E = 67)

R = Line data rate of the telecommunications link in bits per second.

Note: You may need a scientific calculator or a computerized method to do this calculation accurately. For values of R $\geq$ 56000, the R^{th} root of a number less than 1 approaches 1 (but cannot be rounded to 1 for this calculation to be valid). If R = 1344000 and E = 67, for example, P_b is 2.98×10^{-7}.

N = The sum of:

a. The maximum average frame size in bytes that the bridge is expected to process

b. The length of the frame telecommunications header; always 8 bytes.

The formula for the **Telecommunications link error threshold** value specified during bridge program configuration, in number of frames not forwarded per 10,000 arriving, is:

$\text{Threshold} \approx 10{,}000 \times [1 - (1 - P_b)^{8N}]$ frames

Table 13-6. Default Values for the Telecommunications Link Error Threshold			
If you have the following line data rate	**Then use the following default threshold value (frames/10,000)**	**Assumed maximum average frame size in bytes**	**Approximate bit error rate**
9.6 Kbps	**1581**	516	4.17 X 10^{-5}
19.2 Kbps	**815**	516	2.06 X 10^{-5}
38.4 Kbps	**1173**	1500	1.04 X 10^{-5}
56 Kbps	**1085**	2052	7 X 10^{-6}
64 Kbps	**972**	2052	6.23 X 10^{-6}
256 Kbps	**253**	2052	1.56 X 10^{-6}
512 Kbps	**127**	2052	7.83 X 10^{-7}
1.344 Mbps	**49**	2052	2.98 X 10^{-7}

The approximate bit-error rates in this table are based on a % error-free-seconds value of 67%.

The formula used by the Bridge Program to calculate the telecommunications link error threshold assumes the values provided in this table for the maximum average frame size and the "worst case" approximate bit-error rate.

Table 13-7. Estimated Telecommunications Link Error Threshold Values

Maximum Average Frame Size	Telecommunications Link Data Rate / Bit-Error Rate							
	9.6 Kbps/ 4.17 X 10^{-5}	**19.2 Kbps/ 2.06 X 10^{-5}**	**38.4 Kbps/ 1.04 X 10^{-5}**	**56 Kbps/ 7 X 10^{-6}**	**64 Kbps/ 6.23 X 10^{-6}**	**256 Kbps/ 1.56 X 10^{-6}**	**512 Kbps/ 7.83 X 10^{-6}**	**1.344 Mbps/ 2.98 X 10^{-7}**
100	328	163	83	56	50	12	6	2
200	645	324	165	111	99	25	13	5
300	952	482	247	167	148	37	19	7
400	1249	638	327	222	197	50	25	10
500	1536	791	407	276	246	62	31	12
600	---	---	487	330	295	75	38	14
700	---	---	566	384	343	87	44	17
800	---	---	644	438	391	99	50	19
900	---	---	721	492	439	112	56	21
1000	---	---	798	545	486	124	62	24
1100	---	---	875	597	533	136	69	26
1200	---	---	950	650	581	149	75	29
1300	---	---	1025	702	627	161	81	31
1400	---	---	1100	754	674	173	87	33
1500	---	---	1173	806	720	185	94	36
1600	---	---	---	857	766	198	100	38
1700	---	---	---	908	812	210	106	40
1800	---	---	---	959	858	222	112	43
1900	---	---	---	1009	904	234	118	45
2000	---	---	---	1060	949	247	124	48
2052	---	---	---	1086	972	253	128	49

Performance Statistics

Once each minute, the bridge programs use the performance counter values to determine whether the Bridge performance threshold, and the Telecommunications link error threshold for the remote bridge function, have been exceeded. A high value in one or more of the "Frames not forwarded" performance counters (except "Filtered" and "Frames not routed across this bridge") can cause a threshold to be exceeded.

If a threshold is exceeded, the following events occur:

1. The count of the number of times a threshold has been exceeded is incremented in the appropriate 5-minute interval in the Bridge Program Performance Statistics.

   You can display the Bridge Program Performance Statistics panel at the bridge station to see the number of times either or both thresholds were exceeded during any 5-minute interval of a 24-hour period.

2. A performance notification is sent to any network manager program that has established a link with the bridge program (the notification is recorded in the IBM LAN Manager's Event Log).

   The performance notification includes the values of the performance counters (except "Filtered," "Telecommunications link error; bytes," and "Frames not routed across this bridge").

Bridge Traffic Evaluation

You can use the bridge performance information to obtain:

- A characterization of the traffic flowing through a bridge
- An evaluation of bridge traffic on a LAN segment to which more than one bridge is connected.

The **first step** in evaluating bridge traffic is to determine the length of time for which you want the bridge program to accumulate numbers of frames and bytes in the counters:

- If you are going to display the counter values at the bridge station, the IBM LAN Manager station, or the IBM LAN Network Manager station, you need to determine the length of the *measurement period*. The measurement period is:
  - At the bridge station, the length of time between when you reset the bridge performance counters to zeros and when you display the counters and record the accumulated values.
  - At the IBM LAN Manager or LAN Network Manager station, the length of time between the first time you display and record the counter values and the second time you display and record the counter values (after a period of counter accumulation).

  You can wait a few minutes or an hour or more before displaying the accumulated counter values at the bridge, IBM LAN Manager, or LAN Network Manager station.
- If you want to record accumulated counter values in an IBM LAN Manager (Version 2.0 only) counter file, you need to determine:
  - The length of the IBM LAN Manager *performance notification interval*. The IBM LAN Manager Version 2.0 allows you to specify an interval of 1 to 99 minutes, during which the bridge accumulates counter values. Each time the interval elapses, the bridge sends a performance notification containing the counter values to the IBM LAN Manager Version 2.0 to be recorded as a data record in the counter file.
  - The length of time during which you want the bridge to send performance notifications to the IBM LAN Manager for the counter file. The bridge will send a performance notification each time the interval elapses:
    - Until you indicate to the IBM LAN Manager Version 2.0 that recording is to stop
    - Until the counter file fills up (the file can contain 1440 data records, enough for one record every minute over a 24-hour period).

The length of time that counter values are accumulated can vary depending on the purpose of the evaluation.

Short periods of accumulation (a few minutes) can be used to:

- Isolate a specific problem
- Observe traffic at particular times of the day
- Observe traffic generated by particular devices or programs.

Longer periods of time (an hour or more) can provide information about average bridge traffic over a particular time period.

Using a short performance notification interval to collect multiple counter value readings over a period of several hours can help you identify traffic peaks and trends.

The **second step** is to obtain the bridge performance counter values.

You can obtain the counter values:

- At the bridge station by selecting the Bridge Program Performance Counters panel from the bridge program Main Menu (not displayed by the IBM 8209 Utility Program)
- At the IBM LAN Manager station, by:
  - Using the **Bridge Profile** function to display the Bridge Performance Counters panel
  - Using the IBM LAN Manager Version 2.0 **Configure Bridge** function to specify a non-zero performance notification interval to begin recording the counters in the counter file
- At the IBM LAN Network Manager station, by:
  - Using the **Bridges** function to display the Bridge Profile window
  - Choosing the **Performance Data** function from the Bridge Profile window action bar to to specify a non-zero performance notification interval to begin recording the counters in the Bridge Performance Table.

Table 13-8 on page 13-23 indicates the counter values that are:

- Displayed on the Bridge Performance Counters panel at a bridge station, an IBM LAN Manager station, or an IBM LAN Network Manager station
- Sent to the IBM LAN Manager or LAN Network Manager by a bridge program
- Recorded in an IBM LAN Manager counter file or in an IBM LAN Network Manager Bridge Performance Table.

Table 13-8. Bridge Performance Counters								
	IBM Token-Ring Network Bridge Program				**IBM PC Network Bridge Program**	**IBM LAN Manager**		**IBM LAN Network Manager**
Counter	**V1.1**	**V2.0**	**V2.1**	**V2.2**		**V1.0**	**V2.0**	**V1.0**
Broadcast frames forwarded	D, S	D, S	D, S	D, S	D, S	D	D, C	B, X
Broadcast bytes forwarded	D, S	D, S	D, S	D, S	D, S	D	D, C	B, X
Non-broadcast frames forwarded	D, S	D, S	D, S	D, S	D, S	D	D, C	B, X
Non-broadcast bytes forwarded	D, S	D, S	D, S	D, S	D, S	D	D, C	B, X
Frames not forwarded; target LAN segment inoperative	D, S	D, S	D, S	D, S	D, S	D	D, C	B, X
Frames not forwarded; adapter congestion	D, S	D, S	D, S	D, S	D, S	D	D, C	B, X
Frames not forwarded; telecommunications link error			D, S	D, S			D, C	B, X
Bytes not forwarded; telecommunications link error			D	D, S			C	X
Frames not forwarded; other reasons	D, S	D, S	D, S	D, S	D, S	D	D, C	B, X
Frames not forwarded; filtered			D	D				X
Frames not routed across this bridge					D			

Note:

B = Displayed on the Performance Data Window (IBM LAN Network Manager)
D = Displayed on the Bridge Performance Counters panel (IBM LAN Manager)
S = Sent to the IBM LAN Manager; recorded in the Event Log
C = Sent to the IBM LAN Manager Version 2.0; recorded in a counter file
X = Sent to the IBM LAN Network Manager; recorded in the Bridge Performance Table

Performance Analysis Calculations

You can use the performance counter values in a series of calculations to provide additional information about the bridge traffic flow, including:

- User traffic through a bridge in frames per second and bytes per second
- Percentage of frames not forwarded due to causes indicated by the counters.

There are three methods of obtaining the counter values and performing the calculations:

The Worksheet Method
To use the Worksheet Method:

- Display the counters at the bridge station, the IBM LAN Manager station, or the IBM LAN Network Manager station.
- Manually record the counter values on an analysis worksheet.
- Use the recorded values to do the calculations shown on a calculations worksheet.

Refer to the "The Worksheet Method" on page 13-25 for instructions on using the Worksheet Method for bridge traffic evaluation.

The Counter File Method
To use the Counter File Method:

- Use the function provided by the IBM LAN Manager Version 2.0 to record the counter values in a disk file each time the specified performance notification interval elapses.
- Write a program to analyze the data in the counter file.
- Use a program that you write to read the file, do the analysis calculations, and present the results.

See "The Counter File Method" on page 13-27 and refer to the *IBM LAN Manager Version 2.0 User's Guide* for more information on using the counter file.

The Bridge Performance Table Method
To use the Bridge Performance Table Method:

- Use the function provided by IBM LAN Network Manager Version 1.0 to accumulate the results of a specific bridge's performance in the IBM LAN Network Manager database.
- View or print the results using the Bridge Performance option of the LAN Network Manager Report Menu described in the *IBM LAN Network Manager User's Guide*.
- Export the results to a spreadsheet. See "Table Method" on page 13-35 and the *IBM LAN Network Manager User's Guide* for more information on using the Bridge Performance Table Method.

The Worksheet Method

Table 13-9 lists the worksheets that help you record the counter values for one measurement period and perform analysis calculations. A similar table appears at the front of Appendix B, which contains the worksheets.

Table 13-9. Selecting the Proper Bridge Performance Analysis Worksheet

Worksheet	**IBM Token-Ring Network Bridge Program**	**IBM PC Network Bridge Program**	**IBM LAN Manager**	**IBM LAN Network Manager**
Bridge Performance Analysis Worksheet	V1.1, V2.0			
Bridge Performance Analysis Worksheet (Using the Local Bridge Function)	V2.1, V2.2			
Bridge Performance Analysis Worksheet (Using the Remote Bridge Function)	V2.1, V2.2			
Bridge Performance Analysis Worksheet for the IBM PC Network Bridge Program		V1.0	V2.0	V1.0
Bridge Performance Analysis Worksheet for the IBM LAN Manager or the IBM LAN Network Manager			V1.0, V2.0	V1.0
Remote Bridge Performance Analysis Worksheet for the IBM LAN Manager V2.0 or the IBM LAN Network Manager			V2.0	V1.0
Bridge Performance Analysis Calculations Worksheet	V1.1, V2.0		V1.0, V2.0	V1.0
Bridge Performance Analysis Calculations Worksheet (Using the Local Bridge Function)	V2.1, V2.2-Local		V1.0, V2.0	V1.0
Remote Bridge Performance Analysis Calculations Worksheet	V2.1, V2.2-Remote		V2.0	V1.0
Bridge Performance Analysis Calculations Worksheet for the IBM PC Network Bridge Program		V1.0		

The Bridge Performance Analysis Worksheets

The Bridge Performance Analysis Worksheet and instructions for its use are located in the *User's Guide* for each bridge program and in Appendix B of this manual.

The Bridge Performance Analysis Worksheet (Using the Local Bridge Function), the Bridge Performance Analysis Worksheet (Using the Remote Bridge Function), and instructions for their use are located in the *IBM Token-Ring Network Bridge Program Version 2.1 User's Guide*, the *IBM Token-Ring Network Bridge Program Version 2.2 User's Guide*, and in Appendix B of this manual.

The Bridge Performance Analysis Worksheet for the IBM PC Network Bridge Program and instructions for its use are located in the *IBM PC Network Bridge Program User's Guide* and in Appendix B of this manual.

The worksheets are used at a bridge station to record the values of the performance counters displayed on the Bridge Program Performance Counters panel at the end of a measurement period.

The instructions for each worksheet explain how to:

- Set the counters to zeros before beginning the measurement period
- Display the accumulated counter values at the end of the measurement period
- Record the counter values and other information on the worksheet.

The Bridge Performance Analysis Worksheets for the IBM LAN Manager and the LAN Network Manager

The Bridge Performance Analysis Worksheet for the IBM LAN Manager and the LAN Network Manager is used for the IBM 8209 LAN Bridge and for all bridge programs except the IBM Token-Ring Network Bridge Program Versions 2.1 and 2.2 using the remote bridge function which uses the Remote Bridge Performance Analysis Worksheet for the IBM LAN Manager or the LAN Network Manager.

The Bridge Performance Analysis Worksheet for the IBM LAN Manager and instructions for its use are located in each *IBM LAN Manager User's Guide* and in Appendix B of this manual.

The Bridge Performance Analysis Worksheet for the IBM LAN Network Manager and instructions for its use are located in each *IBM LAN Network Manager User's Guide* and in Appendix B of this manual.

The Remote Bridge Performance Analysis Worksheet for the IBM LAN Manager is located in the *IBM LAN Manager Version 2.0 User's Guide* and in Appendix B of this manual.

The Remote Bridge Performance Analysis Worksheet for the IBM LAN Network Manager is located in the *IBM LAN Network Manager User's Guide* and in Appendix B of this manual.

You can use the IBM LAN Manager **Bridge Profile** function to obtain the performance counter values from the bridges and to display the counter values. The IBM LAN Manager and the bridges must be configured to allow the IBM LAN Manager to establish a communication link with a bridge, over which the bridge can send information to the IBM LAN Manager.

You can use the IBM LAN Network Manager **Bridges** function to obtain the performance counter values from the bridge programs and to display the counter values. The IBM LAN Network Manager and the bridge programs must be configured to allow the IBM LAN Network Manager to establish a communication link with a bridge program, over which the bridge program can send information to the IBM LAN Network Manager.

The instructions for each worksheet tell you how to:

- Record the counter values and other information at the beginning of the measurement period

  The copy of the performance counters used by network manager programs cannot be reset to zeros at the start of the measurement period. (Not setting the counters to zeros allows more than one network manager program to access them at one time.)

- Record the counter values again at the end of the measurement period
- Take the difference between the counter values at the two times to obtain the values accumulated during the measurement period
- Correct the accumulated values in case any counter reached its maximum value and reset to zero before continuing to count ("rolled over") during the measurement period.

The Bridge Performance Analysis Calculations Worksheets

The Bridge Performance Analysis Calculations Worksheets use the counter values obtained at the bridge, the IBM LAN Manager station, or the IBM LAN Network Manager station, in a number of bridge traffic measurement computations, including:

- Frames per second forwarded through a bridge
- Bytes per second forwarded through a bridge
- Percentage of frames not forwarded through a bridge.

You can choose only the computations required for your evaluation; most evaluations will not require all of the computations shown on the worksheets.

The Bridge Performance Analysis Calculations Worksheets and instructions for their use are located in Appendix B.

The instructions with each worksheet explain how to:

- Transfer information from the analysis worksheets to the calculations worksheets
- Perform the computations on both sides of the worksheets.

"Bridge Performance Considerations" on page 13-36 contains information to help you use the computation results in managing bridge traffic flow in your network.

The Counter File Method

The IBM LAN Manager Version 2.0 provides a function that:

- Automates the recording of bridge program performance counter values
- Can record counter values for each bridge with which the IBM LAN Manager has established a reporting link (up to 64 bridges).

When you use the **Configure Bridge** function of the IBM LAN Manager to specify a non-zero performance notification interval for a bridge, the IBM LAN Manager:

- Creates a file on the fixed disk; the file has the same name as the bridge and a file extension of PRF
- Requests the bridge program at the bridge station to begin sending accumulated counter values each time the specified performance notification interval elapses
- Writes a record in the file each time counter values are received from the bridge.

The Counter File

The IBM LAN Manager Version 2.0 creates a counter file on the fixed disk each time you specify a non-zero performance notification interval for a bridge with which there is an established communication link. Performance information can be collected concurrently for multiple bridges; there is a separate counter file for each bridge.

Each disk file in which the IBM LAN Manager Version 2.0 records counter values has the following characteristics:

- Each file contains one header record and up to 1440 binary data records.
  - 1440 data records provide enough space for taking a counter reading every minute for 24 hours.
- Each record is 100 characters long.
  - Figure 13-2 on page 13-29 shows the header record format.
  - The fields in the data record are listed on page 13-30.

The header record is written as soon as the file is created. The first data record is written as soon as the first interval elapses and the IBM LAN Manager Version 2.0 receives the first set of counter values.

Counter values are recorded in the file each time the interval elapses, until:

- The counter file is full (contains 1440 data records).
- You specify a performance notification interval of 0 to the IBM LAN Manager.

When the file is full (contains 1440 data records), the IBM LAN Manager:

- Closes the file
- Resets the performance notification interval for that bridge to 0
- Logs message 186, "Bridge parameter has been changed," in the Event Log.

If a counter file for a bridge already exists on disk, the file is erased and a new file is created the next time a non-zero interval is specified for that bridge. If you want to save counter files for later analysis or history, you need to rename the files or copy them to another disk directory or diskette before new files are created.

Bridge Name	Date	Time	First LAN Segment Number	Bridge Number	Second LAN Segment Number	Performance Notification Interval	Reserved

Figure 13-2. Bridge Performance Counter File: Header Record Format

The Bridge Name is in ASCII; the rest of the fields in the header record are binary. The fields in the header record contain the following information:

Table 13-10. Bridge Header Record Field Descriptions

Byte	Description
1–8	Bridge Name (in ASCII) The name specified for this bridge in the Bridge Definition
9–10	Year of the date when the file was started
11	Month of the date when the file was started
12	Day of the date when the file was started
13	Hours of the time when the file was started
14	Minutes of the time when the file was started
15	Seconds of the time when the file was started
16–17	First LAN segment number
18	Bridge number
19–20	Second LAN segment number
21	The performance notification interval, in minutes
22–100	Reserved

Fields in the data records are binary and contain the counter values for both LAN segments connected to the bridge, in the following sequence:

Table 13-11. Bridge Data Record Field Descriptions

Bytes 1 – 50	***Counters for First LAN Segment***
1 – 4	Broadcast frames forwarded
5 – 10	Broadcast bytes forwarded
11 – 14	Non-broadcast frames forwarded
15 – 20	Non-broadcast bytes forwarded
21 – 24	Frames not forwarded; target LAN segment inoperative
25 – 28	Frames not forwarded; adapter congestion
29 – 32	Frames not forwarded; telecommunications link error
33 – 38	Bytes not forwarded; telecommunications link error
39 – 42	Frames not forwarded; other reasons
43 – 50	Reserved
Bytes 51 – 100	***Counters for Second LAN Segment***
51 – 54	Broadcast frames forwarded
55 – 60	Broadcast bytes forwarded
61 – 64	Non-broadcast frames forwarded
65 – 70	Non-broadcast bytes forwarded
71 – 74	Frames not forwarded; target LAN segment inoperative
75 – 78	Frames not forwarded; adapter congestion
79 – 82	Frames not forwarded; telecommunications link error
83 – 88	Bytes not forwarded; telecommunications link error
89 – 92	Frames not forwarded; other reasons
93 – 100	Reserved

Notes:

1. The “Frames not forwarded; filtered” counter is not passed in the performance notification to the IBM LAN Manager Version 2.0, and is not displayed on the IBM LAN Manager Bridge Performance Counters panel. You must use the Worksheet Method at the bridge station to obtain this counter value for your calculations.
2. The “Frames not routed across this bridge” counter is not passed in the performance notification to the IBM LAN Manager Version 2.0, and is not displayed on the IBM LAN Manager Bridge Performance Counters panel. You must use the Worksheet Method at an IBM PC Network bridge station to obtain this counter value for your calculations.

The Analysis Program

To use a counter file for bridge performance analysis, you will need to write a program to:

Read the counter file records
The program should open the file at the beginning and close the file at the end.

As the program reads from the file, it should establish the constants and variables needed for input to the analysis calculations and for saving the results.

Note: The counter files are created in **non-shared mode**. The IBM LAN Manager and the analysis program cannot access a counter file simultaneously. One program must close a counter file and cease access to it before another program can open and use it.

Perform the analysis
The program could do some or all of the calculations shown on the Calculations Worksheets, and you can add other calculations to meet the needs of your evaluation.

Calculations can be done for:

- One performance notification interval (the first one in the file, the last one in the file, or any one in between)
- Selected (not necessarily consecutive) notification intervals from the file
- Consecutive notification intervals over a selected time period

Present the results
Your program could do one or more of the following:

- Save the results in a disk file or database
- Print the results in tables or graphs
- Display the results on the computer screen
- Present just the results
- Present both the results and the values of the constants and variables used to obtain the results

The results you choose to obtain may vary, depending on your reasons for evaluating the bridge traffic, including:

- Isolating a problem
- Tracking peaks and trends
- Balancing traffic flow and workload
- Anticipating future network growth and change

The analysis program can be executed:

- On a computer other than the IBM LAN Manager station (copy the counter file to a diskette for transfer to the other computer)
- As a background task on the IBM LAN Manager computer.

Analyzing the First Notification Interval: To analyze the counter data recorded in the file for the first notification interval only, your program should contain the following steps:

Note: The first performance notification interval that can be analyzed is actually the *second* interval that has elapsed since the counter file was created. The first data record is not recorded until the interval has elapsed one time. The second data record is recorded after the interval has elapsed the second time. Analysis of counter values require two data records to be able to calculate the counter values accumulated over an interval.

1 Open the counter file.

2 Read the header record.

a. Establish the constants and variables for headings and labels to be printed or displayed with the results (Bridge Name, Date, Time, LAN Segment Numbers, Notification Interval). The Bridge Name is in ASCII; all other header fields are in binary.

b. Establish the constants and variables needed for the calculations (Time, Notification Interval, Counter Values). Be sure the variables are large enough to hold both the input values and the result values. Adding two counter values can result in a value exceeding 56,000,000,000,000,000.

c. Provide for conversion of binary data to decimal data where required for presentation or use by the language in which the program is written.

3 Multiply the Notification Interval by 60 to obtain the length of the interval in seconds. (This value corresponds to J — the Measurement wait time — on the calculations worksheets.)

4 Read the first data record.

The counter values in this record correspond to the values labeled "First" on the IBM LAN Manager Bridge Performance Analysis Worksheets.

Establish a variable for each counter on each of the two LAN segments.

5 Read the second data record.

The counter values in this record correspond to the values labeled "Second" on the Worksheets.

Establish a variable for each counter on each LAN segment.

6 For each pair of "First" and "Second" counter values, compare the "First" counter value to the "Second" counter value.

a. If the "Second" value is less than the "First" value, the counter has rolled over during the measurement period.

   Do the following calculation and save the result:

   Result = (Roll over count) + (Second) - (First)

   where the "Roll over count" is the maximum value reached by the counter:

   - For the IBM Token-Ring Network Bridge Program Versions 2.0, 2.1, and 2.2 and for the IBM PC Network Bridge Program (counter lengths are shown in the table on page 13-14).:

For the 4-byte counters:	4,294,967,296
For the 6-byte counters:	281,474,976,710,656

   - For the IBM Token-Ring Network Bridge Program, Version 1.1 (counter lengths are shown in the table on page 13-14):

For the 2-byte counters:	65,536
For the 4-byte counters:	4,294,967,296
For the 6-byte counters:	281,474,976,710,656

b. If the "Second" value is greater than the "First" value, do the following calculation and save the result:

   Result = (Second) − (First)

7 Add the counter Result values for the two LAN segments to get the Bridge Total for each counter, and save the totals.

8 Do the calculations required for the evaluation and save the results.

9 Present the results in one or more of the following ways:

a. Print graphs or tables
b. Display one or more panels on the computer monitor
c. Save the results in an output file.

10 Close the files.

Analyzing Any Single Notification Interval: To analyze the counter data for any single notification interval recorded in the file, your program should contain the steps for the first notification interval plus the following additional steps:

After reading the header record, your program should contain a way to locate the two data records for the notification interval to be analyzed.

Two possible methods are:

- Write your program to accept a number n, indicating the location of the first of two consecutive data records in the file. The number could be a load parameter, or the program could prompt you to type it.

  (For example, to use the fifth and sixth data records in the file, you would specify the number 5.)

  Then, instead of analyzing the first and second data records from the file, your program would read the n^{th} and $n^{th}+1$ records before doing the calculations.

  (Remember, the first **data** record is the **second** record in the file; the header record is the first record in the file.)

- Write your program to accept a time of day relating to the notification interval you want to analyze.

  Have the program use the time the file was started and the notification interval length to locate the two records for the desired notification interval.

  (Remember, the first data record is not written until **after** one performance notification interval has elapsed.

Once the two records are located, have your program do the desired calculations and present the results.

Analyzing Multiples of the Notification Interval: To analyze counter data for a period of time that spans several sequential notification intervals, your program again must be able to locate the two data records containing counter values at the beginning and at the end of the total time period.

To analyze counter data for several non-sequential intervals your program must repeat the steps as many times as required for:

- Locating the two required data records for each interval
- Doing the calculations
- Presenting the results.

Table Method

Determine the length of time for which you want a bridge program to count frames and bytes before you begin the analysis.

The length of the measurement period can be from a few minutes to several hours and will vary with the purpose of the evaluation.

In this method, the user starts a periodic measurement of a specific bridge's performance and the results are accumulated in the Bridge Performance Table. The results can be viewed and printed by using the Bridge Performance Option of the LAN Network Manager Report Menu. This method is available only from the controlling LAN Network Manager.

To use this method:

- Select the number of records to log per bridge.
- Select the bridge from the Defined Bridges window.
- Use the Display Profile and Performance Data options to obtain the Performance Data window.
- Set the Performance Notification Interval to the desired measurement interval in minutes, from 00 to 99.
- At any time, or after the measurement ends, the accumulated bridge performance data can be viewed and printed by using the Bridge Performance Option of the LAN Network Manager Report Menu, in Query Manager. Follow the procedure in *IBM LAN Network Manager User's Guide*.

  Also, the bridge performance data can be exported in several spreadsheet formats by using standard Query Manager functions, if the user wants to do additional performance calculations.
- The measurement can be stopped at any time by setting the Performance Notification Interval to 00.

Bridge Performance Considerations

The following are some considerations that may be useful in managing the traffic flowing through a bridge.

Bridge performance is a part of total network performance. The bridge program performance counters and statistics are intended to provide part of the information you need to diagnose and correct problems reported by users of the network.

Diagnosis

One difficulty in problem diagnosis is that different problems appear to have the same symptom as seen by a user. For example, slow response time can result from:

- File server overload (too many concurrent users)
- Fixed disk fragmentation from modifications
- Heavy LAN segment traffic
- Heavy bridge traffic.

Diagnosis will depend upon your knowledge of network operation in addition to the available status, error information, and bridge traffic measurements.

LAN Segment Utilization

For an IBM Token-Ring Network, the recommendation in the *IBM Token-Ring Network Introduction and Planning Guide* concerning ring utilization can also help in regulating bridge utilization. If ring utilization is planned to average 30% of capacity, a bridge could usually handle the flow even if all of the ring traffic were sent through the bridge. The IBM Token-Ring Network Trace and Performance Programs can be used to measure source and destination ring utilization.

For an IBM PC Network, the Advanced Diagnostics packaged with the *IBM PC Network Hardware Maintenance and Service* manual provide a function to measure the percent of utilization of a IBM PC Network Bus. Once started, the Network Utilization function runs continuously until you stop it, and displays:

- Average use
- Present use
- Highest use
- Lowest use.

The percentages are updated on the panel as the usage of the IBM PC Network Bus changes.

Frames Not Forwarded

The **Bridge performance threshold** bridge configuration parameter indicates the maximum acceptable number of frames not forwarded per 10,000 frames received at the bridge, due to an inoperative LAN segment, adapter congestion, and invalid frames.

The **Telecommunications link error threshold** bridge program configuration parameter indicates the acceptable number of frames sent onto the telecommunications link but not received at the other bridge half, per 10,000 frames received at a bridge using the remote bridge function, due to errors on the telecommunications link connecting the two stations of the bridge.

One or more occurrences of either threshold being exceeded could result in a problem detectable by network users. The performance statistics collected and displayed by the bridge program show the number of times either threshold has been exceeded in each 5-minute interval of a 24-hour period.

If the occurrences of either threshold being exceeded are frequent, you might consider:

- Increasing the threshold parameter value in the bridge program configuration file, if the occurrences do not seem to be connected with or causing user problems
- Investigating further if the occurrences correspond to particular periods of the day, to user complaints, or to particular errors (such as remote bridge telecommunications link errors).

The values of the bridge program "Frames not forwarded" performance counters indicate possible causes of the threshold being exceeded. A high value in:

- The "Frames not forwarded; target LAN segment inoperative" counter indicates that the target (destination) LAN segment is malfunctioning and is unable to receive frames from the bridge.

  The count also includes:

  – Frames discarded by the bridge that were waiting at the bridge to be forwarded when the destination ring began beaconing
  – Frames that the bridge discarded after experiencing 16 consecutive collisions in attempting to forward the frames to the target IBM PC Network Bus.

  There should be other status and error indications to help you isolate and resolve the LAN segment problem (from the bridge program, the IBM LAN Manager, the IBM LAN Network Manager, other programs that provide trace and status information, or an application program on the malfunctioning LAN segment).

- The "Frames not forwarded; adapter congestion" counter has two possible causes:

  – The bridge is overloaded. A symptom will be a high percentage of frames not processed by the bridge in both flow directions.

    This condition can be caused by frames arriving at the bridge from the source LAN segment faster than the bridge can accept them from the adapter and process them. If the source LAN segment adapter is an IBM PC Network adapter, it may be running out of memory buffer space. On an IBM Token-Ring Network, a heavy traffic flow to the bridge can cause the bridge program to run out of internal control blocks.

    This condition can also result from using a slower bridge computer between two fast LAN segments (for example, a PS/2 Model 30 between two 16-Mbps rings).

  – The destination (target) LAN segment is too busy to accept frames as fast as the bridge or telecommunications link is forwarding them.

This condition could happen when a source user LAN segment is sending frames to a busy backbone LAN segment, or when a fast source LAN segment (a 16-Mbps ring, for example) is sending frames to a slower destination LAN segment (a 2-Mbps IBM PC Network Bus, for example) or across a slower telecommunications line (9.6 Kbps, 56 Kbps, or 1.344 Mbps).

Possible solutions for these conditions include:

- For a bridge connecting two IBM PC Network segments:

  1. Re-evaluate utilization of LAN segments.
  2. Separate one or both LAN segments into two or more LAN segments, and place bridges between the appropriate LAN segments.
  3. Place some stations on a LAN segment that uses a different frequency pair. Place bridges as needed between frequency pairs. (Do not create parallel bridges between PC Network segments that use the same frequency pair.)
  4. Install a bridge computer with a faster processor. For example, upgrade the bridge computer from a PS/2 Model 50 to a PS/2 Model 80.

- For a bridge connecting an IBM Token-Ring Network segment and an IBM PC Network segment:

  1. Re-evaluate utilization of LAN segments.
  2. Rearrange applications to that those that send and receive large amounts of data are all connected to the IBM Token-Ring Network segment.
  3. Separate one or both LAN segments into two or more LAN segments, and place bridges between the appropriate LAN segments.
  4. Place some stations on another IBM PC Network LAN segment that uses a different frequency pair. Place bridges as needed between LAN segments and frequency pairs. (Do not create parallel bridges between PC Network segments that use the same frequency pair.)
  5. Install a bridge computer with a faster processor. For example, upgrade the bridge computer from a PS/2 Model 50 to a PS/2 Model 80.

- For a bridge connecting two IBM Token-Ring Network segments:
  1. Re-evaluate utilization of LAN segments.
  2. Rearrange application programs to put those that exchange large amounts of data on the same LAN segment.
  3. Install a bridge computer with a faster processor. For example, upgrade the bridge computer from a PS/2 Model 50 to a PS/2 Model 80.
  4. Install a parallel bridge.
  5. For a bridge using the remote bridge function, also consider:
     a. Installing a telecommunications link with better quality and/or a higher line data rate.
     b. Filtering frames to forward specific traffic across the bridge.

  The traffic being sent to a large backbone LAN segment through bridges can be estimated by summing the frames or bytes forwarded to it by each connecting bridge during the same time period. The IBM LAN Manager Version 2.0 counter file function or the IBM LAN Network Manager Bridge Performance Table function could be used to collect frame and byte counts from the bridges to which they have links established.

- The "Frames not forwarded; other reasons" counter indicates that the bridge is receiving invalid frames from a malfunctioning attaching device (either the frame is too long, the frame is too short, or the routing information is invalid). See the counter description on page 13-10 for details.

- The "Frames not forwarded; telecommunications link error" counter indicates errors on the telecommunications link connecting the two stations of a bridge using the remote bridge function.

  Possible solutions for high values in this counter include:

  - Adjustment of the **Telecommunications link error threshold** value (see the recommendations on page 13-18) if counter values are high without indications of user complaints
  - Re-evaluation of telecommunications link quality and speed.

Considerations for Using the Remote Bridge Function

Because a telecommunications link is used to connect the two halves of the bridge, you must consider a number of factors in the use of the IBM Token-Ring Network remote bridge function that do not apply to bridges that use local bridge function.

These factors include:

- Bridge variables associated with the telecommunications link

  These variables either are or affect parameter values specified at bridge configuration and installation:

  - The maximum frame size that can cross the telecommunications link
  - The bridge communications adapter transmit buffer size
  - The line data rate of the telecommunications link

  Although these values are specified as bridge parameters, the values must correspond to similar values specified as configuration parameters for programs and devices that communicate on the network and through the bridge. The network administrator must coordinate all of these parameter values for network devices, programs, and bridges.

- LAN segment and network characteristics

  These characteristics are a direct result of the physical and logical layout of the network: which programs and devices are connected to which LAN segment, which programs and devices need to communicate across a bridge, and what kind and volume of traffic is exchanged over the network and particularly across a bridge. Such characteristics include:

  - The number of network users that can send information across the bridge, and that can send information across the bridge at the same time

  - The bridge traffic profile (constant or sporadic; large frames, small frames, or a mixture; broadcast or non-broadcast frames)

- End user station operating characteristics and variables

  These characteristics and variables include:

  - IEEE 802.2 LLC T1 timer (the allowed round trip delay between the sending of a frame and the return of receipt acknowledgment to the sender, before the frame is considered lost and the sender retries transmission)

  - IEEE 802.2 LLC N2 (the number of times the sender can retry a transmission before an "unable to transmit" error is generated)

  - IEEE 802.2 MAXOUT (the number of frames a sender can transmit before requiring receipt acknowledgment from the receiver)

  - Maximum frame size (the largest frame size that can be sent or received by a device, program, protocol, and/or interface).

  The existence of and value specified for each of these variables is usually dependent on the type of device, program, and protocol used at an end user station. The smallest IEEE 802.2 LLC timer value used by a station on either LAN segment connected by the bridge is used to determine the bridge communications adapter transmit buffer size parameter value. The maximum frame size sent to the bridge must not exceed the maximum frame size that the bridge program can process (specified during bridge configuration).

Remote bridge function support of connection-oriented traffic requires considerations not needed for connectionless traffic. Connection-oriented traffic requires periodic acknowledgment from the receiver to the sender that frames have been received. Connectionless traffic does not require acknowledgment of receipt.

Programs and devices that use connection-oriented protocols on the network contain function to acknowledge the receipt of frames, and to detect that a transmitted frame has not been received and acknowledged within an allotted time interval. The time interval required for a frame to be sent over the network, received, and acknowledged by the receiver is called *network delay*. Connections for communication between unique pairs of source and destination addresses can be lost when the network delay for frames sent across the bridge is excessive and when excessive numbers of transmission retries exhaust the retry counters IEEE 802.2 LLC (N2).

The allotted time interval for network delay is usually specified as the IEEE 802.2 LLC T1 timer value in device and program configuration. Network delay for frames crossing a bridge using the remote function depends on:

- Line data rate
- Frame size
- The number of frames queued at the communications adapter and waiting to be sent out on the telecommunications link

  The queue at the communications adapter can build up when data arrives at the adapter faster than the link can accept and transmit the data.

  The maximum size of the queue depends on:

  - Bridge traffic characteristics
  - Line data rate
  - Available adapter transmit buffer space

  Even when pacing methods (such as the MAXOUT parameter) are used, bursts of traffic arriving at the bridge can build up and fill up the queue. Bursts of traffic become increasingly likely as the number of unique pairs of source and destination addresses that concurrently use the bridge increases.

All of these factors interrelate to affect the performance of a bridge that uses the remote bridge function. Bridge program, device, and application program parameter values can be adjusted to achieve optimum performance of a bridge that uses the remote bridge function. The interrelationships of the factors are complex and very much dependent on network and end-user characteristics.

For example, consider the following:

- You can adjust the IEEE 802.2 LLC timer values used for programs on the network and for the bridge communications adapter transmit buffer size calculation to allow for greater network delay.

  Program products tend to use the same IEEE 802.2 LLC timer value for all communication connections that use a given protocol. Increasing the IEEE 802.2 LLC timer values for users of the bridge can cause performance problems for connections that do not use the bridge.

- You can adjust the bridge communications adapter transmit buffer size.

  Limiting buffer size can increase adapter congestion, filling up the transmit queue faster and therefore increasing the number of transmission retries for frames that could not be put on the full queue.

  Such limiting of the buffer size decreases the occurrence of IEEE 802.2 LLC timer expirations and resulting protocol violations when frames arrive after the timer expires, but the potential for transmission retries increases.

- A large MAXOUT parameter value may increase performance for a single dedicated connection between two users of the bridge. A large MAXOUT value for multiple connections using the bridge will probably result in increased network delay and adapter congestion for frames crossing the bridge.

- The maximum frame size processed by the bridge also affects the number of concurrent connections that the bridge can support for a given buffer size, congestion level, and set of traffic characteristics.

  The smaller the maximum frame size, the larger the number of concurrent connections the bridge can support. The fewer concurrent connections the bridge must support, the larger the maximum frame size can be for optimum performance.

Filter programs can be used with bridges that use the remote bridge function. Filter programs can help to achieve optimum bridge performance by:

- Routing only necessary traffic across the bridge, and not allowing other traffic to cross.

  Filter programs can select the frames that cross a bridge based on criteria such as frame type, adapter source and/or destination address, and NETBIOS or other network names.

- Limiting the number of unique pairs of source and destination addresses that can access the bridge concurrently.

  Adapter congestion can be reduced or avoided by limiting the number of concurrent users of the bridge. A single dedicated connection using a bridge will probably not experience network delay.

  Some network configurations can be used to both limit the number of concurrent bridge users and still serve a large number of network users. Such configurations include:

  - A local IBM 3174 can connect to the network and provide communication through a bridge with a remote IBM 3174 for many attached workstations.
  - A local server can provide data and services to a remote server across a bridge. The remote server in turn can service remote stations.

You may want to consult with IBM or other professional network specialists in adjusting these factors for optimum performance of your bridges and network.

Diagnosis

The following programs can be used to measure source and destination ring utilization:

- The IBM Token-Ring Network 16/4 Trace and Performance Program (for 4- and 16-Mbps rings)
- The IBM Token-Ring Network Trace and Performance Program (for 4-Mbps rings only).

The IBM Token-Ring Network 16/4 Trace and Performance Program

The IBM Token-Ring Network 16/4 Trace and Performance Program is a software tool to aid in problem determination and performance analysis on a 4- or 16-Mbps IBM Token-Ring Network segment.

The 16/4 Trace and Performance Program runs in a station on the network that contains one of the following special adapters:

- An IBM Token-Ring Network 16/4 Trace and Performance Adapter (for IBM Personal Computers and IBM PS/2 computers that use PC I/O Channel architecture)
- An IBM Token-Ring Network 16/4 Trace and Performance Adapter/A (for IBM PS/2 computers that use Micro Channel architecture).

The 16/4 Trace and Performance Program measures activity and saves data only on the ring to which it is attached. Interpretation of the trace, performance, and analysis data requires a knowledge of the IBM Token-Ring Network architecture and physical transport protocols, Logical Link Control (LLC) protocols, and protocols used by attaching devices.

16/4 Trace and Performance Program Functions

The 16/4 Trace and Performance Program provides six functions:

- The Trace Facility
- The Trace Analysis Facility
- The Performance Facility
- The Performance Analysis Facility
- The Traffic Matrix Facility
- The Traffic Matrix Analysis Facility.

The Trace Facility

This function collects trace data in a disk or diskette file for one or any combination of:

- Medium Access Control (MAC) frames only
- Non-MAC frames only
- All frames on the LAN segment
- Frames going to and received from a set of adapter addresses.

Tracing can be started or stopped manually by an operator, or can be triggered by time-of-day parameters or frame data patterns. The trace data can include each whole frame or just the first buffer of each frame to obtain header and control fields.

To decrease the amount of trace data to analyze, you might elect to trace:

- The header and control fields if ring or application program errors indicate invalid frame control fields or routing information
- Whole frames if errors indicate invalid data in frames
- Frames to and from specific addresses involved in a particular session or fault domain.

The Trace Facility does not participate in the normal neighbor notification process on the ring. Soft error reporting is masked for errors that occur between the tracing station's upstream neighbor and downstream neighbor.

Because the Trace and Performance Program adapters can copy all frames that are sent on the ring, there is the potential of recording classified or restricted information in the trace data. You may want to use the IBM LAN Manager program option that allows the IBM LAN Manager to be notified when a Trace and Performance Program adapter becomes active on a ring. The IBM LAN Manager can remove an unauthorized trace adapter from the ring if the tracing of classified data would pose a security risk (all trace data is also erased). Or you may want to restrict the access to and use of the program, the hardware used to run it, and the analysis output.

The Trace Analysis Facility

This function helps you review, analyze, summarize, index, and display the data collected by the Trace Facility. The Trace Analysis Facility can display, print, or store:

- The ring network address configuration

  If you trace all frames, or trace MAC frames only and all addresses, this option displays neighbor notification cycles (or ring poll cycles). The address of each adapter on the ring is displayed, beginning with the Active Monitor and proceeding around the ring in downstream sequence.

- A summary of information about the frames traced and the frame sequence occurring on the ring

  The summary includes address, SAP, and routing information from the frame header and control fields, along with frame type interpretation for MAC, non-MAC, LLC, SNA, NETBIOS, and TCP/IP frames.

  Analysis and summary can also be done by specific fields or patterns in the header, control, and data portions of the frames.

- The contents of each frame in byte-by-byte detail

  The Display Frame Detail option can be used to analyze the contents of a selected frame in detail, with the data portion (information field) displayed in hexadecimal digits and your choice of ASCII or EBCDIC characters.

The Performance Facility

This function is used to obtain ring performance and utilization measurements. The Performance Facility monitors ring traffic, collecting frame and byte counts in a disk or diskette file for one or any combination of:

- MAC frames
- Non-MAC frames
- All frames
- Frames going to and received from a set of adapter addresses
- Frames within a specific size range or ranges.

The Performance Facility displays either of two panels that show realtime performance data in two different formats:

- The Token-Ring Utilization in % panel displays two bar graphs and two numbers that show the current ring traffic as a percentage of the maximum traffic that can be on the ring (4 or 16 Mbps).

Frames and bytes are counted as they pass through. The total utilization, user data utilization, and ring status are displayed and refreshed every 2 seconds.

- The Ring Utilization History panel displays a bar graph of total ring utilization over the 2 hours preceding the current time and refreshes the panel every 4 minutes.

The Performance Analysis Facility

This function helps you review and analyze the data captured by the Performance Facility. The Performance Analysis Facility can display, print, or store summary reports and can print or store graphs and tables.

- Display Ring Performance Summary

  The summary includes frames per second, bits per second, and percentage of bandwidth used for the frame type chosen for analysis. A distribution of frames by length is also shown.

  The report is written to a disk or diskette file that can be viewed with a text editor or printed.

- Output Ring Performance Graphs

  The ring performance graphs illustrate average performance measurements for the time period during which the Performance Facility was operating on the observed ring (the maximum period of observance in one file is 24 hours). You can choose to print the graphs or to save the graphs in a file to be printed later.

  The graphic report contains six bar charts:

  - Total number of frames counted per second
  - Number of non-MAC frames counted per second
  - Number of user frames counted per second, reflecting user data throughput
  - Total number of bytes counted per second
  - Number of bytes in non-MAC frames counted per second
  - Number of bytes in user frames counted per second.

  These charts, used with the performance summary, give you an accurate illustration of ring performance.

- Output Ring Performance Tables

  This function prints or stores two tables that show the amount of ring traffic over a period of time.

  - The Performance by Time Table lists the number of frames per second and bits per second for each 1-minute period.
  - The Distribution by Time Table lists the number of frames of a given size for each 1-minute period.

The Traffic Matrix Facility

This facility collects information about traffic (non-MAC frames only) sent between station pairs on the observed ring. This information can help you determine:

- Which stations are most active on the ring
- How many frames each station is sending and receiving
- The type and size of the frames a station is sending and receiving
- Whether particular station pairs are exchanging unusually large amounts of data.

Each time a non-MAC frame is sent between a station pair, the Traffic Matrix Facility records the source and destination addresses, the frame type, and the number of bytes contained in the frame. The matrix information is saved in a file that is updated every hour.

The Traffic Matrix Facility does participate in the normal neighbor notification process on the ring.

The Traffic Matrix Analysis Facility

This function helps you view and analyze the data captured by the Traffic Matrix Facility. You can display, print, or store a traffic data summary that lists:

- The 10 most active source and destination addresses
- The 10 most active address pairs
- The number of frames and bytes sent to, from, and between these addresses.

The function also creates a traffic detail report that you can either print or file. The report shows:

- Each source and destination address found on the ring, in the order you specify (either most to least active, or least to most active)
- The number of non-MAC frames and bytes sent or received by these addresses
- A breakdown by type of the number of non-MAC frames and bytes sent or received.

The IBM Token-Ring Network Trace and Performance Program

The IBM Token-Ring Network Trace and Performance Program is a software tool to aid in problem determination and performance analysis on a 4-Mbps IBM Token-Ring Network.

The Trace and Performance Program runs in a station on the network that contains an IBM Token-Ring Network Trace and Performance Adapter II or Adapter/A.

The Trace and Performance Program measures activity and saves data only on the ring to which it is attached. Interpretation of the trace, performance, and analysis data requires a knowledge of the IBM Token-Ring Network architecture and physical transport protocols, Logical Link Control (LLC) protocols, and protocols used by attaching devices.

Trace and Performance Program Functions

The Trace and Performance Program provides four functions:

- The Trace Facility
- The Trace Analysis Facility
- The Performance Facility
- The Performance Analysis Facility.

The Trace Facility

This function collects trace data on a disk or diskette file for one or any combination of:

- Medium Access Control (MAC) frames
- Non-MAC frames
- All frames
- Frames going to and received from a set of adapter addresses.

Tracing can be stopped or started manually by an operator, or can be triggered by time-of-day parameters or frame data patterns. The trace data can include each whole frame or just the first buffer of each frame to obtain header and control fields.

You might elect to trace:

- The header and control fields if ring or application program errors indicate invalid frame control fields or routing information
- Whole frames if errors indicate invalid data in frames
- Frames to and from specific addresses involved in a particular session or fault domain, to decrease the amount of trace data to analyze.

The Trace Facility does not participate in normal ring protocol.

Because the Trace and Performance Program adapters can copy all frames that are sent on the ring, there is the potential of recording classified or restricted information in the trace data. You may want to use the IBM LAN Manager program option that allows the IBM LAN Manager to be notified when a Trace and Performance Program adapter becomes active on a ring and can remove the adapter from the ring if the tracing of classified data would pose a security risk. Or you may want to restrict the access to and use of the program, the hardware used to run it, and the analysis output.

The Trace Analysis Facility

This function displays the data collected by the Trace Facility:

- In summary mode, one frame per line

  The summary is useful for determining the frame sequence occurring on the ring. It includes frame header and control information along with frame type.

  Analysis can be done by frame type (MAC, LLC, SNA, or NETBIOS) and by fields or patterns in the header, control, and data portions of the frames.

- In byte-by-byte detail

  Note: A frame can be selected from the summary and displayed in detail. The data portion is displayed in hexadecimal digits and your choice of ASCII or EBCDIC characters.

The Performance Facility

This function monitors ring traffic, collecting frame and byte counts on a disk or diskette file for one or any combination of:

- Medium Access Control (MAC) frames
- Non-MAC frames
- All frames
- Frames going to and received from a set of adapter addresses.

Two panels can be displayed:

- The Token-Ring Network Ring Utilization panel, showing the current ring traffic as a percentage of the maximum traffic that can be on the ring (4 Mbps).

  Frames and bytes are counted as they pass through. The total utilization, user data utilization, and ring status are displayed and refreshed every 2 seconds.

- The Ring Utilization History, showing a bar graph of total ring utilization over the preceding 2 hours.

The Performance Analysis Facility

This function provides summary and detail reports from the data collected by the Performance Facility:

- Performance Summary

  The summary includes frames per second, bytes per second, and percentage of bandwidth used for the frame type chosen for analysis. A distribution of frames by length is also shown.

  The report is written to a disk or diskette file that can be viewed with a text editor or printed.

- Detail Report

  The detail report shows frames per second and bytes per second formatted in graphs or tables and written to a disk or diskette file.

  The graphic report contains bar charts (one for each of six sampling intervals), formatted to print two charts per 8-1/2 by 11-inch page on a graphics printer. The graphs cannot be viewed by a text editor.

The tabular report contains tables of the same information shown in the graphs (one table for each of six sample intervals). The tables can be viewed with a text editor, or printed; the tables allow printing of the analysis report when a non-graphics printer is used.

Chapter 14. Network Management

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The following network management programs operate on the indicated LANs:

Network Management Program	IBM Token-Ring Network	IBM PC Network		MAP	Ethernet
		Broadband	Baseband		
IBM LAN Manager Version 1.0	Yes	Yes	No	No	
IBM LAN Manager Version 2.0	Yes	Yes	No	No	
IBM LAN Network Manager Version 1.0	Yes	Yes	Yes	No	
IBM LAN Manager Entry	Yes	Yes	Yes	No	
IBM PC 3270 Emulation LAN Management Program	Yes	Yes	Yes	No	
IBM Personal Communications/3270 Emulation Program	Yes	Yes	Yes	No	
IBM Token-Ring Network Manager [1]	V1.0, V1.1	V1.1	No	No	
NetView	Yes	Yes	Yes	No	
NetView/PC	Yes	Yes	No	No	
DCAF	Yes	No	No	No	
LANACS2.0	Yes	Yes	Yes	No	Yes

[1] This product is no longer available from IBM.

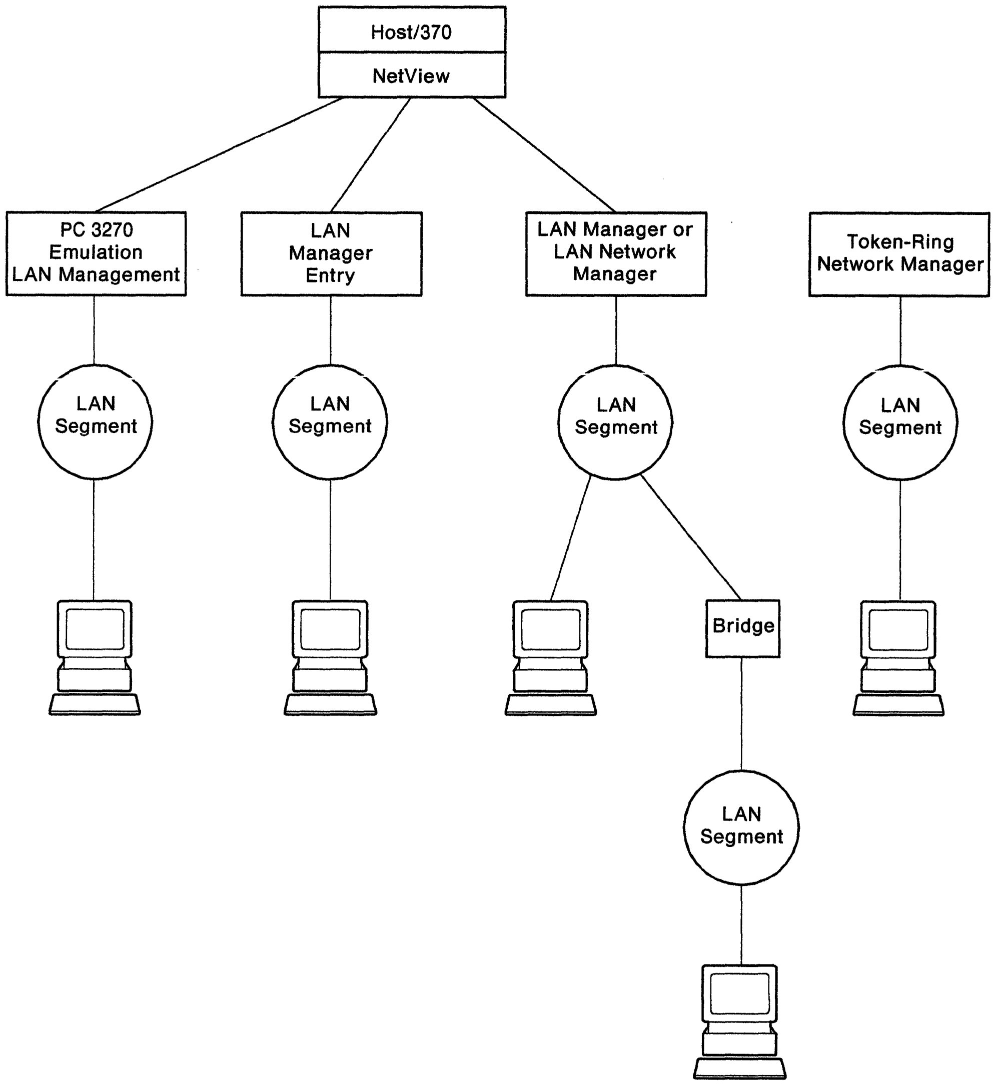

Figure 14-1. LAN Management Programs Used on a LAN

Overview of Network Management Programs

The table on page 14-1 identifies specific LAN management programs that operate on the indicated LANs. Figure 14-1 shows the scope of monitoring and reporting capabilities of each LAN management program. The remainder of this chapter discusses each program in detail.

If you need to know about a specific LAN management program, go directly to the section that describes that program. Each program's characteristics are described independently. You do not need to read about all the LAN management programs to understand what any one does. However, you may want to read about all of them when picking the best one to serve your specific needs.

Network Management Programs and Device Configuration Utilities

The network management programs and some device driver configuration utilities cannot run concurrently in the same workstation with one network adapter present. It is possible to run them together using two network adapters. The configuration utilities and the network management programs use common SAPs. The mutually exclusive programs are:

- LAN Network Manager Version 1.0
- LAN Manager Version 2.0
- IBM 8209 Utility Program Versions 2.0 and 3.0
- IBM Token-Ring Network Bridge Program Version 2.2 Dial Application.

The IBM LAN Manager Version 1.0

The IBM LAN Manager is a network management program and problem determination aid for the IBM Token-Ring Network and the IBM PC Network Broadband. It runs as a stand-alone program or as an application under the NetView/PC program. On an IBM Token-Ring Network, the IBM LAN Manager monitors activity on the LAN segment to which it is attached and on remote LAN segments connected by bridges. On the IBM PC Network, it monitors activity only on the LAN segment to which it is attached.

The IBM LAN Manager allows you to manage a LAN by maintaining records, monitoring the status of the LAN segments and attaching devices, and determining the source of problems on a LAN segment. You can test a LAN segment to make sure that data is flowing around it, and you can remove active devices that are not functioning correctly. Refer to the *IBM LAN Manager User's Guide* for detailed information about this program.

The IBM LAN Manager runs in an IBM Personal Computer or IBM Personal System/2 computer attached to a LAN segment of an IBM Token-Ring Network or an IBM PC Network Broadband. The program package provides:

- Aids to help you install the IBM LAN Manager on a fixed disk
- A migration aid to help you update your fixed disk and convert existing files if you were previously using the IBM Token-Ring Network Manager (Version 1.0 or 1.1)
- Functions to define certain characteristics of your network to the IBM LAN Manager, including:
  - Names and addresses by which the IBM LAN Manager is known in network communication and status information
  - Symbolic names of the adapters on the network
  - Bridges and reporting links between the IBM LAN Manager and any remote LAN segments.

Program panels allow you to select the function you want to use, by typing a word or number or by pressing a key. Other panels display information that you request, or help you understand how to use the functions and keys. You may also print panels and reports.

The IBM LAN Manager provides functions to:

- Change the defined IBM LAN Manager and network operating characteristics
- Display alerts and recommended actions for resolving them
- Support remote console operation through NetView/PC
- Send alerts through NetView/PC to NetView at a host computer
- Log events on the LAN segment, including soft and hard errors, configuration changes, and adapter removals
- Display a list of the fault domain adapter pairs, prioritized by severity of error
- Request and print reports from the event log
- Display and print a LAN segment configuration
- Display adapter status

- Remove an adapter from a LAN segment
- Assign symbolic names to adapter addresses on the LAN segments
- Test the path between two adapters
- Assign or change a password to authorize operator access to the IBM LAN Manager
- Establish or terminate reporting links with bridges
- Obtain and display a bridge's configuration parameters and performance counters
- Change the bridge single-route broadcast parameter setting.

IBM LAN Manager (Version 1.0) Output

The IBM LAN Manager supplies information about the operating status of LAN segments, about its own operating status, and about problems on specific LAN segments.

LAN Segment Status: This indicates a variety of conditions of the LAN segments to which the IBM LAN Manager is attached:

Normal: The IBM LAN Manager is processing information, and the LAN segment is operating normally.

Adapter Closed: The adapter used by the IBM LAN Manager is no longer logically attached to the LAN segment.

Data Lost: The IBM LAN Manager currently cannot log errors as fast as they are occurring. Some error information will be lost.

Soft Error: (Token-Ring segment only) The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly. The alert that accompanies the *Soft Error* status includes the fault domain: the segment of the network experiencing the failures.

Wire Fault: (Token-Ring segment only) There is a problem between the IBM LAN Manager's attaching device and the access unit to which it is connected. The attaching device, the cable from the device to the access unit, or the access unit could be the source of the problem. The IBM LAN Manager's adapter is closed.

Beaconing: (Token-Ring segment only) The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating on the network within the predefined time limit.

Continuous Carrier: (PC Network segment only) An IBM PC Network adapter or the modem on the adapter is in a continuous transmit mode. No other IBM PC Network adapters can transmit until the problem is resolved. The bus is inoperative. The bus can automatically recover if the problem adapter removes itself.

No Carrier: (PC Network segment only) A cable located between the IBM LAN Manager and the translator unit is loose or broken, or there is a problem in the translator unit such as no power. On a remote LAN segment, the problem may be a loose or broken bridge cable, or a problem in the translator unit on that LAN segment.

IBM LAN Manager Status: This indicates the functional status of the IBM LAN Manager itself. Messages displayed about the IBM LAN Manager indicate:

- The status of the IBM LAN Manager's adapter
- The status of the function the IBM LAN Manager is performing
- Any IBM LAN Manager error conditions.

Messages and Alerts: As the status of a LAN segment changes, alerts (to indicate serious errors) and messages are generated. This is detailed information used partly to find a problem on a LAN segment, and partly for your service supplier if you are unable to resolve the problem. These messages provide additional information about the functioning of:

- The LAN segment to which the LAN Manager is connected
- The IBM LAN Manager itself
- The adapter used by the IBM LAN Manager
- Reporting links from the IBM LAN Manager to bridges in the network
- Remote LAN segments monitored by the IBM LAN Manager.

You can use the information provided by the IBM LAN Manager for problem determination in an IBM Token-Ring Network instead of or in addition to that supplied by the Ring Diagnostic for a single LAN segment. The links to remote LAN segments through bridges provide a means of locating network problems without initially having to be at the LAN segment incurring the problem.

The *IBM LAN Manager User's Guide* contains a "Basic Troubleshooting" chapter that helps you use IBM LAN Manager messages and alerts to begin to resolve a problem. The *User's Guide* also contains explanations of the messages and alerts displayed by the IBM LAN Manager.

The Event Log: The IBM LAN Manager provides a log of seven types of LAN segment and IBM LAN Manager events:

1. Soft errors
2. A LAN segment status of *Beaconing*, *Continuous Carrier*, or *No Carrier*
3. The status of the IBM LAN Manager's adapter
4. Changes in the operation of IBM LAN Manager functions (such as full or limited soft error logging on/off, reset error counters, LAN segment test status, and data loss)
5. Network events (such as new LAN segment monitor, adapter removed from LAN segment, and bridge activity)
6. Configuration changes on the IBM LAN Manager's LAN segment and on remote LAN segments
7. Adapter insertions.

The event log can be displayed, or data from the log can be printed in reports.

IBM LAN Manager (Version 1.0) Connections to Remote LAN Segment

On the **IBM PC Network**, the IBM LAN Manager monitors activity only on the LAN segment to which it is attached.

On the **IBM Token-Ring Network**, the IBM LAN Manager can establish communication links with up to 32 bridges at a time. The IBM Token-Ring Network Bridge Program (Version 1.1 or higher) can collect error, status, and bridge traffic information for the two LAN segments connected to the bridge. The Bridge Program can send the collected information to up to four network manager programs that have established communication links with the bridge.

The information received by IBM LAN Manager from the Bridge Program:

- Is recorded as entries in the IBM LAN Manager Event Log
- Includes some of the information that would be collected by the IBM LAN Manager if it were running on either of the LAN segments connected to the bridge.

As the Network Administrator, you choose values for the IBM LAN Manager System Definition and the Bridge Program configuration parameters. You should select the values so that the IBM LAN Manager does not receive duplicate status, error information, and configuration changes for its own LAN segment or for any remote LAN segments.

- The IBM LAN Manager collects status, soft and hard error reports, and configuration changes for the LAN segment to which it is attached.
- On remote LAN segments having links established with the IBM LAN Manager, only one bridge per LAN segment should report LAN segment status, error information, and configuration changes to the IBM LAN Manager.

The following table shows the Bridge Program and IBM LAN Manager parameter settings that should avoid duplicate reporting:

Table 14-1. Bridge Program and IBM LAN Manager Parameter Settings

Bridge Location	**Parameters Set in Bridge Program Configuration File**	**Bridge Definition Parameters Set Using LAN Manager**
LAN Segment Common to Bridge 1 and LAN Manager	Ring Error Monitor = **Yes** Configuration Report Server = **No**	Error Reports = **No**
LAN Segment Connected to Other Side of Bridge 1	Ring Error Monitor = **Yes** Configuration Report Server = **No**	Error Reports = **Yes**
LAN Segment Remote from Bridge 1 that Communicates through Bridge 1	Ring Error Monitor = **Yes** Configuration Report Server = **No**	Error Reports = **Yes**

The IBM LAN Manager Version 2.0

The IBM LAN Manager is a network management program and problem determination aid for a LAN composed of one or more IBM Token-Ring Network segments or IBM PC Network Broadband segments. It runs under OS/2 Extended Edition Version 1.1 as a stand-alone program or in communication with the NetView program. The IBM LAN Manager monitors activity on the LAN segment to which it is attached and on remote LAN segments connected by bridges. After the program is started, it can be left unattended to run continuously. If the program terminates abnormally, it creates an error log file.

The IBM LAN Manager allows you to manage a LAN by maintaining records, monitoring the status of LAN segments and attaching devices, and determining the source of problems on a LAN segment. The program has an Alert Transport Facility that sends alerts received from other application programs on the same LAN segment to the NetView program. An *alert* is a notification indicating an interruption in the flow of data around the network or a potential interruption, or a possible security violation. You can test a LAN segment to make sure that data is flowing around it, and you can remove active devices that are not functioning correctly. Refer to the *IBM LAN Manager Version 2 User's Guide* for detailed information about this program.

The IBM LAN Manager runs in an IBM Personal Computer XT* Model 286, an IBM Personal Computer AT, or an IBM Personal System/2 (PS/2) computer Model 50, Model 60, Model 70, or Model 80 attached to an IBM Token-Ring Network or broadband IBM PC Network. The program package provides:

- Aids to help you install the IBM LAN Manager on a fixed disk
- A migration aid to help you update your fixed disk and convert existing files if you were previously using the IBM Token-Ring Network Manager (Version 1.0 or 1.1) or the IBM LAN Manager Version 1.0
- Functions to define certain characteristics of your network to the IBM LAN Manager, including:
  - Names and addresses by which the IBM LAN Manager is known in network communication and status information
  - Symbolic names of the adapters on the network
  - Bridges and reporting links between the IBM LAN Manager and any local or remote LAN segments.

Program panels allow you to select the function you want to use, by typing a letter or by pressing a key. Other panels display information that you request, or help you understand how to use the functions and keys. You may also print panels and reports.

The IBM LAN Manager provides functions to:

- Change the defined IBM LAN Manager and network operating characteristics
- Display alerts and recommended actions for resolving them
- Send alerts through NetView/PC or the OS/2 Communication Manager to NetView at a host computer
- Log events on the LAN segments, including soft and hard errors, configuration changes, and adapter removals

- Display a list of the adapters experiencing the most soft errors
- Request and print reports from the event log
- Display and print a LAN segment configuration
- Display adapter status
- Remove an adapter from a LAN segment
- Assign symbolic names to adapter addresses on the LAN segments
- Test the path between two adapters
- Assign or change a password to authorize operator access to the IBM LAN Manager
- Establish or terminate reporting links with bridges
- Obtain and display a bridge's configuration parameters and performance counters
- Change the bridge's parameters from the LAN Manager console.

The LAN Manager program can respond to Service Point Command Service (SPCS) commands issued by a network operator at a NetView host. SPCS commands allow the network operator to request status information about a LAN segment and perform certain control functions for error recovery and problem determination. The NetView operator can send the following 11 SPCS commands to the LAN Manager program:

1. **Query Adapter Profile** displays current status information about a LAN segment workstation.
2. **Remove Adapter** logically removes an adapter from the LAN segment.
3. **Display Network Configuration** displays the current configuration of a LAN segment.
4. **Run LAN Segment Test** tests whether a LAN segment is capable of transferring data.
5. **Reset LAN Manager** causes the LAN Manager application to terminate any bridge links, close its adapter, re-initialize all its components, reopen its adapter, and establish a link with any bridges defined to be linked at initialization of the LAN Manager.
6. **Display Network Status** displays a list of all LAN segments currently managed by the LAN Manager.
7. **Perform Path Test** tests whether two LAN adapters can communicate across a specified path.
8. **Link Bridge** lets the NetView operator establish a communications link with a bridge defined to the LAN Manager.
9. **Unlink Bridge** lets the NetView operator terminate a communications link between a bridge and the LAN Manager.
10. **Query Bridge** displays status information about a bridge.
11. **Configure Bridge** lets the NetView operator change bridge configuration parameters in a bridge linked to the LAN Manager.

IBM LAN Manager (Version 2.0) Output

The IBM LAN Manager supplies information about the operating status of LAN segments, about its own operating status, and about problems on specific LAN segments.

LAN segment Status: This indicates a variety of conditions of the LAN segment to which the IBM LAN Manager is attached:

Normal: The IBM LAN Manager is processing information, and the LAN segment is operating normally.

Adapter Closed: The adapter used by the IBM LAN Manager is no longer logically attached to the LAN segment.

Data Lost: The IBM LAN Manager currently cannot log errors as fast as they are occurring. Some error information will be lost.

Soft Error: (Token-Ring segment only) The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly. The alert that accompanies the *Soft Error* status includes the fault domain: the segment of the network experiencing the failures.

Wire Fault: (Token-Ring segment only) There is a problem between the IBM LAN Manager's attaching device and the access unit to which it is connected. The attaching device, the cable from the device to the access unit, or the access unit could be the source of the problem. The IBM LAN Manager's adapter is closed.

Beaconing: (Token-Ring segment only) The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating the network within the predefined time limit.

Continuous Carrier: (PC Network segment only) An IBM PC Network adapter or the modem on the adapter is in a continuous transmit mode. No other IBM PC Network adapters can transmit until the problem is resolved. The bus is inoperative. The bus can automatically recover if the problem adapter removes itself.

No Carrier: (PC Network segment only) A cable located between the IBM LAN Manager and the translator unit is loose or broken, or there is a problem in the translator unit such as no power. On a remote LAN segment, the problem may be a loose or broken bridge cable, or a problem in the translator unit on that LAN segment.

IBM LAN Manager Status: This indicates the functional status of the IBM LAN Manager itself. Messages displayed about the IBM LAN Manager indicate:

- The status of the IBM LAN Manager's adapter
- The status of the function the IBM LAN Manager is performing
- Any IBM LAN Manager error conditions.

Messages and Alerts: As the status of a LAN segment changes, alerts (to indicate serious errors) and messages are generated. This is detailed information used partly to find a problem on a LAN segment, and partly for your service supplier if you are unable to resolve the problem. These messages provide additional information about the functioning of:

- The LAN segment to which the LAN Manager is connected
- The IBM LAN Manager itself
- The adapter used by the IBM LAN Manager
- Reporting links from the IBM LAN Manager to bridges in the network
- Remote LAN segments monitored by the IBM LAN Manager.

You can use the information provided by the IBM LAN Manager for problem determination in an IBM Token-Ring Network instead of or in addition to that supplied by the Ring Diagnostic for a single LAN segment. The links to remote LAN segments through bridges provide a means of locating network problems without initially having to be at the LAN segment incurring the problem.

The *IBM LAN Manager Version 2 User's Guide* contains a "Basic Troubleshooting" chapter that helps you use IBM LAN Manager messages and alerts to begin to resolve a problem. The *User's Guide* also contains explanations of the messages and alerts displayed by the IBM LAN Manager. Message explanations and recommended actions may also be viewed online at the workstation in which the LAN Manager program is running.

The Event Log: The IBM LAN Manager provides a log of nine types of LAN segment and IBM LAN Manager events:

1. Soft errors
2. A LAN segment status of *Beaconing*, *No Carrier*, or *Continuous Carrier*
3. The status of the IBM LAN Manager's adapter
4. Changes in the operation of IBM LAN Manager functions (such as full or limited soft error logging on/off, reset error counters, LAN segment test status, and data loss)
5. Network events (such as new LAN segment monitor, adapter removed from LAN segment, backup path in use, and bridge activity)
6. Configuration changes on the IBM LAN Manager's LAN segment and on remote LAN segments
7. Adapter insertions
8. Frame tracing and unauthorized tracing attempts
9. Host computer connection failure.

The event log can be displayed, or data from the log can be printed in reports.

IBM LAN Manager (Version 2.0) Connections to Remote LAN Segment

The IBM LAN Manager can establish communication links with up to 64 bridges at a time in a network. The IBM Token-Ring Network Bridge Program (Versions 1.1, 2.0, and 2.1) and the IBM PC Network Bridge Program (Version 1.0) can collect error, status, and bridge traffic information for the two LAN segments connected to the bridge. The Bridge Program can send the collected information to up to four network manager programs that have established communication links with the bridge.

The information received by IBM LAN Manager from the Bridge Program:

- Is recorded as entries in the IBM LAN Manager Event Log
- Includes some of the information that would be collected by the IBM LAN Manager if it were running on either of the LAN segments connected to the bridge.

As the Network Administrator, you choose values for the IBM LAN Manager System Definition and the Bridge Program configuration parameters. The IBM LAN Manager collects status, soft and hard error reports, and configuration changes for the LAN segment to which it is attached. It also collects this information from remote LAN segments for which you have links established through bridges.

The IBM LAN Network Manager Version 1.0

The IBM LAN Network Manager Version 1.0, an enhancement to the IBM LAN Manager Version 2.0, is a network management program and problem determination aid for a LAN composed of one or more IBM Token-Ring Network segments, IBM PC Network Broadband segments, or IBM PC Network Baseband segments. It runs under OS/2 Extended Edition Version 1.2 as a stand-alone program or in communication with the NetView [2] program. LAN Network Manager 1.0 uses OS/2 Presentation Manager and Database Manager. For more information on OS/2 Extended Edition refer to "OS/2 Extended Edition" on page 17-6. The IBM LAN Network Manager monitors activity on the LAN segment to which it is attached and on remote LAN segments connected by bridges. After the program is started, it can be left unattended to run continuously. If the program terminates abnormally, it creates an error log file.

The IBM LAN Network Manager allows you to manage a LAN by maintaining records, monitoring the status of LAN segments and attaching devices, and determining the source of problems on a LAN segment. The program has an Alert Transport Facility that sends alerts received from other application programs on the LAN to the NetView program. An *alert* is a notification indicating an interruption in the flow of data around the network or a potential interruption, or a possible security violation. Alert transport need not be from a station on the same LAN segment. You can test a LAN segment to make sure that data is flowing around it, and you can remove active devices that are not functioning correctly. Refer to the *IBM LAN Network Manager Version 1 User's Guide* for detailed information about this program.

The IBM LAN Network Manager runs in an IBM Personal System/2 (PS/2) computer attached to an IBM Token-Ring Network, broadband IBM PC Network, or baseband IBM PC Network. The program package provides:

- Aids to help you install the IBM LAN Network Manager on a fixed disk
- A migration aid to help you update your fixed disk and convert existing files if you were previously using the IBM Token-Ring Network Manager (Version 1.0 or 1.1) or the IBM LAN Manager (Version 1.0 or 2.0)
- Worksheets to help you plan for the system configuration
- Functions that allow you to use the worksheets to define certain characteristics of your network to the IBM LAN Network Manager, including:
  - Names and addresses by which the IBM LAN Network Manager is known in network communication and status information
  - User-defined names of the adapters on the network
  - IBM 8230 Token-Ring Network Controlled Access Units attached to a Token-Ring managed by the LAN Network Manager
  - Bridges and reporting links between the IBM LAN Network Manager and any local or remote LAN segments.

[2] NetView is a host-based network management program from IBM.

Program windows allow you to select the functions using a keyboard or a mouse. Other windows display information you request, or help you understand how to use the functions and keys. You may also print help windows.

The IBM LAN Network Manager provides functions to:

- Change the defined IBM LAN Network Manager and network operating characteristics
- Display alerts and recommended actions for resolving them
- Send alerts through NetView/PC or the OS/2 Communication Manager to NetView at a host computer
- Log and display events on the LAN segments, including soft and hard errors, configuration changes, and adapter removals
- Display a list of the adapters experiencing the most soft errors
- Display the details of selected events
- Display and print a LAN segment configuration
- Display adapter status
- Remove an adapter from a LAN segment
- Assign user-friendly names to adapter addresses on the LAN segments
- Assign or change a password to authorize operator access to the IBM LAN Network Manager
- Establish or terminate reporting links with bridges
- Automatically re-link bridges after the communication link is lost
- Obtain and display a bridge's configuration parameters and performance counters
- Change the bridge's parameters from the LAN Network Manager station
- Enable an IBM 8230 Token-Ring Network Controlled Access Unit to receive and load new or revised program code
- Analyze the data in the LAN Network Manager Database Table using OS/2's Query Manager.
- Commands an IBM 8230 to disable ports based on
  - Undefined adapter address
  - Undefined bridge adapter
  - Adapter movement
  - Time of Day/Day of Week
- Supports passwords for IBM 8230
- Provides Asset Control.

The LAN Network Manager program can respond to the LAN Network Manager Command List and the RUNCMD equivalent commands issued by a network operator at a NetView host. These commands allow the network operator to request status information about a LAN segment and perform certain control functions for error recovery and problem determination. The NetView operator can send the following 10 commands to the LAN Network Manager program:

1. **Query Adapter Profile** displays current status information about a LAN segment workstation.
2. **Remove Adapter** logically removes an adapter from the LAN segment.
3. **Display Network Configuration** displays the current configuration of a LAN segment.
4. **Run LAN Segment Test** tests whether a LAN segment is capable of transferring data.
5. **Reset LAN Network Manager** causes the LAN Network Manager application to terminate any bridge links, close its adapter, re-initialize all its components, reopen its adapter, and establish a link with any bridges defined to be linked at initialization of the LAN Network Manager.
6. **Display Network Status** displays a list of all LAN segments currently managed by the LAN Manager.
7. **Link Bridge** lets the NetView operator establish a communications link with a bridge defined to the LAN Network Manager.
8. **Unlink Bridge** lets the NetView operator terminate a communications link between a bridge and the LAN Network Manager.
9. **Query Bridge** displays status information about a bridge.
10. **Configure Bridge** lets the NetView operator change bridge configuration parameters in a bridge linked to the LAN Network Manager.

IBM LAN Network Manager (Version 1.0) Output

The IBM LAN Network Manager supplies information about the operating status of LAN segments, about its own operating status, and about problems on specific LAN segments.

LAN Segment Status: This indicates a variety of conditions of the LAN segment to which the IBM LAN Network Manager is attached:

Normal: The IBM LAN Network Manager is processing information, and the LAN segment is operating normally.

Adapter Closed: The adapter used by the IBM LAN Network Manager is no longer logically attached to the LAN segment.

Data Lost: The IBM LAN Network Manager currently cannot log errors as fast as they are occurring. Some error information will be lost.

Unknown: The network status cannot be determined. This condition usually occurs when the the LAN Network Manager is first started and when it is restarted.

Soft Error: (Token-Ring segment only) The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly. The alert that accompanies the *Soft Error* status includes the fault domain, which is the portion of the network experiencing the failures.

Wire Fault: (Token-Ring segment only) There is a problem between the IBM LAN Network Manager's attaching device and the access unit to which it is connected. The attaching device, the cable from the device to the access unit, or the access unit could be the source of the problem. The IBM LAN Network Manager's adapter is closed.

Beaconing: (Token-Ring segment only) The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating on the network within the predefined time limit. The alert that accompanies the *Beaconing* status includes the fault domain, which is the portion of the network experiencing the failures.

Wrapped: (Token-Ring segment only) The LAN segment is now using the backup path.

Continuous Carrier: (PC Network segment only) An IBM PC Network adapter or the modem on the adapter is in a continuous transmit mode. No other IBM PC Network adapters can transmit until the problem is resolved. The bus is inoperative. The bus can automatically recover if the problem adapter removes itself.

No Carrier: (PC Network segment only) A cable located between the IBM LAN Network Manager and the translator unit is loose or broken, or there is a problem, such as no power, in the translator unit. On a remote LAN segment, the problem may be a loose or broken bridge cable, or a problem in the translator unit on that LAN segment.

IBM LAN Network Manager Status: This indicates the functional status of the IBM LAN Network Manager itself. Messages displayed about the IBM LAN Network Manager indicate:

- The status of the IBM LAN Network Manager's adapter
- The status of the function the IBM LAN Network Manager is performing
- Any IBM LAN Network Manager error conditions.

Messages and Alerts: As the status of a LAN segment changes, alerts (to indicate serious errors) and messages are generated. You can use the detailed information in these messages and alerts to find a problem on the network, or your service supplier can use this information if you are unable to resolve a network problem. These alerts and messages provide information about the functioning of:

- The LAN segment to which the LAN Network Manager is connected
- The IBM LAN Network Manager itself
- The adapter used by the IBM LAN Network Manager
- Reporting links from the IBM LAN Network Manager to bridges in the network
- Remote LAN segments monitored by the IBM LAN Network Manager.

You can use the information provided by the IBM LAN Network Manager to perform problem determination in an IBM Token-Ring Network instead of, or in addition to, the information supplied by the Ring Diagnostic for a single LAN segment. The links to remote LAN segments through bridges provide a means of locating network problems without initially having to be at the LAN segment incurring the problem.

The *IBM LAN Network Manager Version 1 User's Guide* contains a "Basic Troubleshooting" chapter that helps you use IBM LAN Manager messages and alerts to begin resolving a problem. The *User's Guide* also contains an explanation of each of the messages and alerts displayed by the IBM LAN Network Manager. You may also view message explanations and recommended actions online at the workstation in which the LAN Network Manager program is running.

The Event Log: The IBM LAN Network Manager provides a log of 10 types of LAN segment and IBM LAN Network Manager events:

1. Soft errors
2. A LAN segment status of *Beaconing*, *No Carrier*, *Continuous Carrier*, or *Wrapped*
3. The status of the IBM LAN Network Manager's adapter
4. Changes in the operation of IBM LAN Network Manager functions (such as full or limited soft error logging on/off, reset error counters, LAN segment test status, and data lost)
5. Network events (such as new LAN segment monitor, adapter removed from LAN segment, backup path in use, and bridge activity)
6. Configuration changes on the IBM LAN Network Manager's LAN segment and on remote LAN segments
7. Adapter insertions
8. Frame tracing and unauthorized tracing attempts
9. Host computer connection failure
10. The status of controlled access units.

The event log can be displayed, or data from the log can be printed in reports.

IBM LAN Network Manager (Version 1.0) Connections to Remote LAN Segment

The IBM LAN Network Manager can establish communication links with up to 255 bridges at a time in a network. The IBM Token-Ring Network Bridge Program (Versions 1.1, 2.0, 2.1, and 2.2) and the IBM PC Network Bridge Program (Version 1.0) can collect error, status, and bridge traffic information for the two LAN segments connected to the bridge. The Bridge Program can send the collected information to up to four network manager programs that have established communication links with the bridge. The LAN Network Manager also provides limited support for the IBM 8209 LAN Bridge. See the *IBM LAN Network Manager User's Guide* for details.

The information received by IBM LAN Network Manager from the Bridge Program:

- Is recorded as entries in the IBM LAN Network Manager Event Log
- Includes some of the information that would be collected by the IBM LAN Network Manager if it were running on either of the LAN segments connected to the bridge.

As the Network Administrator, you choose values for the IBM LAN Network Manager System Parameters, Station Definition, and Bridge Definition configuration parameters. The *IBM LAN Network Manager User's Guide* contains worksheets to help you select these configuration parameters. After you complete the worksheets, the LAN Network Manager operator actually configures the LAN Network Manager using the parameters you have defined. The IBM LAN Network Manager collects status, soft and hard error reports, and configuration changes for the LAN segment to which it is attached. It also collects this information from remote LAN segments for which you have links established through bridges.

The IBM LAN Manager Entry

Refer to the *IBM LAN Manager Entry User's Guide* for detailed information about this program.

The IBM LAN Manager Entry program is a network management program that allows for problem determination and error recovery on single-segment IBM Token-Ring and IBM PC Networks (broadband and baseband). After the program is started, it can be left unattended to run continuously. If the program terminates abnormally, it creates an error log file.

The program monitors a LAN segment for error conditions. As errors occur, it generates alerts and sends them to the NetView program at the host for analysis. The program has an Alert Transport Facility that sends alerts received from other application programs on the same LAN segment to the NetView program. An alert is a notification indicating an interruption in the flow of data around the network or a potential interruption, or a possible security violation.

The LAN Manager Entry program can respond to Service Point Command Service (SPCS) commands issued by a network operator at a NetView host. SPCS commands allow the network operator to request status information about a LAN segment and perform certain control functions for error recovery and problem determination. The network operator can send the following six SPCS commands to the LAN Manager Entry program:

1. **Query Adapter Profile**, displays current status information about a LAN segment workstation.
2. **Remove Adapter**, logically removes an adapter from the LAN segment.
3. **Display Network Configuration**, displays the current configuration of a LAN segment.
4. **Run LAN segment Test**, tests whether a LAN segment is capable of transferring data.
5. **Reset LAN Manager Entry**, causes the LAN Manager Entry workstation to close its LAN adapter, re-initialize all its subcomponents, and reopen the adapter.
6. **Display Network Status**, displays the current status of the LAN segment in which the LAN Manager Entry program resides.

The program also has an Export and Import Utility that allows for the use of symbolic adapter names.

You may configure the LAN Manager Entry to allow or not allow tracing by the IBM Token-Ring Network Trace and Performance Program.

The IBM PC 3270 Emulation LAN Management Program

Refer to the *IBM PC 3270 Emulation LAN Manager User's Guide* for detailed information about this program.

The IBM PC 3270 Emulation LAN Management Program provides single small and remote IBM Token-Ring Network segments or IBM PC Network segments (with no LAN Manager program) the capability for centralized network management. This program resides under an IBM 3270 Emulation Program gateway.

The IBM PC 3270 Emulation LAN Management Program allows you to manage a LAN segment by monitoring the LAN segment for error conditions and providing automatic alert forwarding to a NetView host.

This program:

- Accumulates soft error information for the IBM Token-Ring Network
- Monitors the IBM Token-Ring Network for hard errors
- Monitors the PC Network for continuous carrier or no carrier conditions
- Builds LAN-related alerts for transport to NetView.

This program operates on any IBM Personal System/2 computer or Personal Computer that is configured for the IBM 3270 Emulation Program and uses a host computer gateway link to transport alerts. To send SPCS commands to or receive alerts from the IBM PC 3270 Emulation LAN Management Program, the host must have NetView installed.

The IBM Personal Communications/3270 Emulation Program

Refer to the *IBM Personal Communications/3270 Emulation Program User's Guide* for detailed information about this program.

The IBM Personal Communications/3270 Emulation Program provides all the services of the IBM PC 3270 Emulation LAN Management Program and also integrates the services of the IBM PC 3270 Emulation Program.

The IBM Token-Ring Network Manager

The IBM Token-Ring Network Manager is a network management program and problem determination aid for the IBM Token-Ring Network. It runs in an IBM Personal Computer attached to a single-segment IBM Token-Ring Network.

The IBM Token-Ring Network Manager allows you to manage a single IBM Token-Ring Network segment by maintaining records, monitoring the status of the LAN segment and attaching devices, and determining the source of problems on the LAN segment. You can test the LAN segment to make sure that data is flowing around it, and you can remove active devices that are not functioning correctly. Refer to the *IBM Token-Ring Network Manager User's Guide* for detailed information about this program.

Program panels allow you to select the function you want to use, by typing a word or number or by pressing a key. Other panels display information that you request, or help you understand how to use the functions and keys. You may also print panels and reports.

The Token-Ring Network Manager provides functions to:

- Display alerts and recommended actions for resolving them
- Log events on the LAN segment, including soft and hard errors, configuration changes, and adapter removals
- Display a list of the adapters experiencing the most soft errors
- Display and print the LAN segment configuration
- Display adapter status
- Remove an adapter from the LAN segment
- Assign symbolic names to adapter addresses on the LAN segment
- Test the path between two adapters
- Assign or change a password to authorize operator access to the Network Manager.

IBM Token-Ring Network Manager Output

The IBM Token-Ring Network Manager supplies information about the operating status of the LAN segment, about its own operating status, and about problems on the LAN segment to which the Network Manager is attached.

LAN Segment Status: This indicates a variety of conditions of the LAN segment.

Normal: The Network Manager is processing information, and the LAN segment is operating normally.

Adapter Closed: The adapter used by the Network Manager is no longer logically attached to the LAN segment.

Data Lost: The Network Manager currently cannot log errors as fast as they are occurring. Some error information will be lost.

Soft Error: The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly. The alert that accompanies the *Soft Error* status includes the fault domain, the segment of the network experiencing the failures.

Wire Fault: There is a problem between the Network Manager's attaching device and the access unit to which it is connected. The attaching device or the access unit could be the source of the problem. The Network Manager's adapter is closed.

Beaconing: The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating the network within the predefined time limit.

Network Manager Status: This indicates the functional status of the Network Manager itself. Messages displayed about the Network Manager indicate:

- The status of the Network Manager's adapter
- The status of the function the Network Manager is performing
- Any Network Manager error conditions.

Messages and Alerts: As the status of a LAN segment changes, alerts (to indicate serious errors) and messages are generated. This is detailed information used partly to find a problem on the LAN segment, and partly for your service supplier if you are unable to resolve the problem. These messages provide additional information about the functioning of:

- The LAN segment to which the Network Manager is connected
- The Network Manager itself
- The adapter used by the Network Manager.

You can use the information provided by the Network Manager for problem determination in an IBM Token-Ring Network instead of or in addition to that supplied by the Ring Diagnostic.

The *IBM Token-Ring Network Manager User's Guide* contains a "Basic Troubleshooting" chapter that helps you use Network Manager messages and alerts to begin to resolve a problem. The *User's Guide* also contains explanations of the messages and alerts displayed by the Network Manager.

The Event Log: The Network Manager provides a log of six types of LAN segment and Network Manager events:

1. Soft errors
2. A LAN segment status of *Beaconing*
3. The status of the Network Manager's adapter
4. Changes in the operation of Network Manager functions (such as full or limited error logging on/off, reset error counters, LAN segment test status, and data loss)
5. Network events (such as new LAN segment monitor and adapter removed from LAN segment)
6. Configuration changes on the Network Manager's LAN segment.

The event log can be displayed, or data from the log can be printed in reports.

NetView

NetView is a host-based IBM licensed program that provides communication network management (CNM) services.

Refer to the *IBM NetView Operation Guide* for detailed information about this program. NetView and NetView/PC are separately licensed programs.

NetView Operations

NetView provides a command facility, hardware monitor, session monitor, and status monitor.

The NetView **command facility** lets you control, record, and automate various operator tasks. NetView can be used as an operator's interface to VTAM in a data communication network.

The NetView **hardware monitor** enables you to access problem determination information that is generated at resources that are either link-attached or channel-attached to the host system. The information that is passed to the host consists of events (alerts) and statistics.

The NetView **session monitor** allows you to collect and correlate data about sessions and routes and get online access to the collected data. It allows you, from a central control point, to examine information related to the SNA network and to identify network problems.

The NetView **status monitor** displays network status and accepts network operator commands.

Distributed Console Access Facility (DCAF)

Distributed Console Access Facility (DCAF) is a personal-computer-based remote console facility. DCAF allows one PC to control and monitor the display of another. A controlling station can be used to run most full-screen text-mode applications on a target workstation, including:

- IBM OS/2 LAN Server Version 1.2
- IBM LAN Manager Version 2.0
- User-developed applications
- IBM Token-Ring Network 16/4 Trace and Performance Program.

NetView/PC

NetView/PC is a PC-based IBM licensed program that enables communication between an application running under NetView/PC and the NetView program running in a host computer.

NetView/PC provides the following services for NetView/PC applications:

- System services common to any NetView/PC application such as operator control
- Monitoring and problem determination services
- A communication channel for sending
  - Data such as network management information to NetView
  - Voice data information to Customer Information Control System/Distributed Data Management (CICS/DDM)
- Services that enable customer-written application programs to extend communication network management to non-IBM communication devices. The *NetView/PC Application Programming Interface/Communications Services* manual, SC30-3313, provides complete information on this function.

Refer to the *IBM NetView/PC Operation Guide* for detailed information about the NetView/PC program.

NetView/PC Functions

The NetView/PC program provides the following functions:

- Grouping services — Lets you define which NetView/PC applications you want to run at the same time.
- Operator control — Allows you to specify operator identifiers (IDs) and passwords to control access to the NetView/PC program.
- Remote console — Lets you access a NetView/PC application program from a PC executing another NetView/PC application program.
- Alert and Problem Determination — Allows you to display, add, change, and delete information received from application programs and contained in alert and problem files. Alerts can be sent to NetView at the host.
- Reminder Services — Allows you to set up service reminders, to remind you about events that are to take place or about work still to be done.
- Host Data Facility — Lets you send files to and receive files from CICS/DDM running in a host computer to which the NetView/PC program is attached.

NetView/PC Applications

A NetView/PC application program is usually designed to accompany communication hardware, with problem determination features to test the hardware and its connection to the network. IBM LAN Manager Version 1.0, ROLM Alert Monitor, and ROLM Call Detail Collector are examples of NetView/PC applications. Other application programs are developed by non-IBM sources. See your IBM representative for a list of these non-IBM application programs.

Chapter 15. Bridging Products

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The following bridging products operate on the indicated LANs:

Bridging Product	IBM Token-Ring Network	IBM PC Network		Ethernet/ IEEE 802.3
		Broadband	Baseband	
IBM Token-Ring Network Bridge Program Version 1.1	Yes	No	No	No
IBM Token-Ring Network Bridge Program Version 2.0	Yes	No	No	No
IBM Token-Ring Network Bridge Program Version 2.1	Yes	No	No	No
IBM Token-Ring Network Bridge Program Version 2.2	Yes	No	No	No
IBM PC Network Bridge Program	Yes	Yes	Yes	No
IBM Token-Ring Network/PC Network Interconnect Program	Yes	Yes	No	No
IBM 8209 LAN Bridge	Yes	No	No	Yes

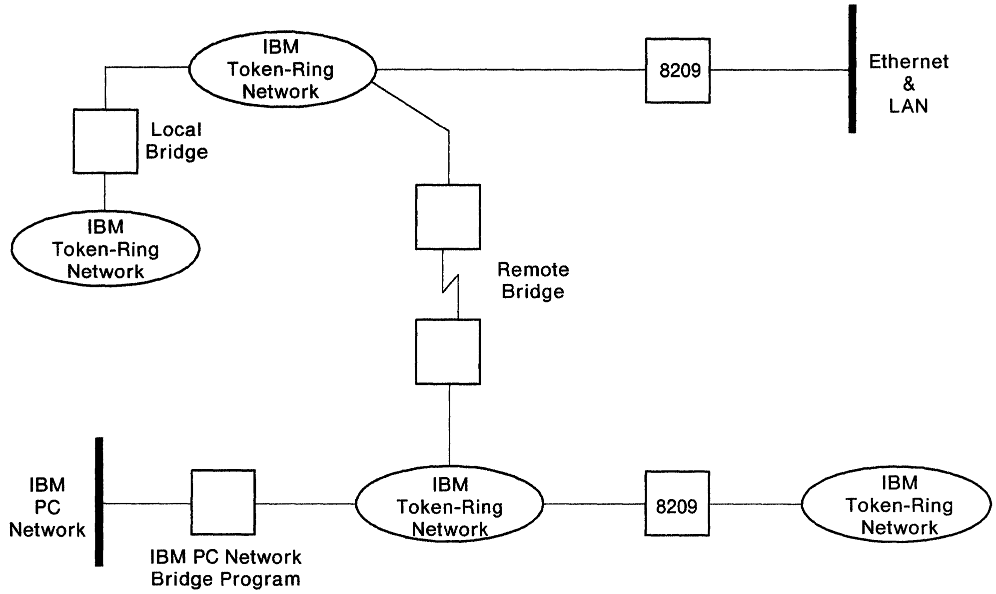


Figure 15-1. IBM Bridging Products Used on LANs

Bridging Products Overview

Bridging products allow you to :

- Form networks with more than the maximum number of attaching devices allowed on a single LAN segment
- Connect and transfer information between different types of LAN segments
- Place print servers and file servers on LAN segments with their most frequent users, yet still have them available to users attached to other LAN segments in the network
- Share communication between hosts and multiple LAN segments most efficiently.

The table on page 15-2 identifies the specific bridging products that operate on each of the indicated LANs. Figure 15-1 shows where these bridging products might be located in a complex LAN. Each product is discussed in detail beginning on page 15-25.

Bridging Concepts

The IBM bridging products used to connect IBM LANs and some non-IBM LANs implement certain bridging concepts from network standards and their associated reference models. The following sections describe the concepts and some details. The sections that describe each bridging product contain further details as they apply to each product and version.

Routing through Bridges

Two methods of determining the route a frame will follow through a network that contains bridges are:

- Source routing
- Transparent bridging.

Source Routing

IBM bridging products used with the IBM Token-Ring Network support the IBM Token-Ring Network implementation of source routing for bridging multi-ring networks.

Source routing requires that the source station on a multi-ring network specify in each frame the rings and bridges that must be crossed in the route to reach the destination station.

To determine the routing information, the source station issues a discovery frame on its ring. If a response is received from the desired destination station, it shows that both the source and destination stations are on the same ring and that no routing information is needed.

If no response is received, the source station issues a multi-ring search frame that fans out to every ring in the network. As the frame is copied from one ring to another, each associated bridge updates the routing information in the search frame. When the search frame finally reaches the destination, it contains the route between the source and destination stations. The destination station then sends a response frame back to the source station with the routing information. Both stations then use the routing information in each subsequent information frame sent between them.

Two options are available for sending a multi-ring search frame:

- The search frame can be sent so that only one copy of the frame is received by the destination station even if multiple paths exist between the source and destination stations. Bridge configuration parameters can be set to ensure that only one bridge between any two rings is authorized to copy and forward the search frame. This option is called *single-route broadcast* by IBM, and *spanning-tree explorer* by IEEE.
- The search frame can be sent so that multiple copies of the frame are received by the destination station if multiple paths exist between the source and destination stations. The destination station receives one copy of the frame for each unique path. This option is called *all-routes broadcast* by IBM, and *all-routes explorer* by IEEE.

The destination station may:

- Send one response frame for each of multiple search frames it received.
- Send, for a single search frame received, an all-routes broadcast response frame. Either response allows the source station the option to choose the route to use to reach the destination station. (The implementation in most IBM station application programs uses the route that is indicated in the first response that returns to the source station.)

Transparent Bridging

Transparent bridging provides an interconnection of LANs that is transparent to stations communicating across a bridge. Any station can communicate with any other station in the network as though both stations were on the same LAN. All routing functions are handled entirely within the transparent bridges.

Transparent bridging requires that the bridges dynamically maintain a source address database for each of their LAN connections. Each bridge connection operates in a *promiscuous* mode so that every frame on the LAN is received. The source address from each frame is saved in the database. The database is then searched to determine if the destination address of the frame is in the database. If so, the frame is discarded since both the source and the destination stations are on the same LAN. If, however, the frame destination address is not found in the database, the bridge forwards the frame to the other LAN segment. This decision process is a type of **filtering**.

Transparent bridging is used on most MAC bridges that interconnect IEEE 802.3 or Ethernet LANs.

Spanning-Tree Protocols

LAN architectures and implementations sometimes require that one and one only copy of a frame or message reach each LAN segment in the network, or that there be only one path between any two LAN segments in the network.

The standards and architectures define *spanning-tree protocols* that bridging products use to help meet such requirements.

Single-Route Broadcast

The spanning-tree protocol implemented in the IBM Token-Ring Network for source routing route discovery is called *single-route broadcast*. Single-route broadcast is a specific type of broadcast frame used in the bridge route discovery process. Only one copy of a single-route broadcast frame is allowed on each LAN segment in the network.

Broadcast Message Types

Broadcast messages provide a way (in addition to group addresses) of sending information to multiple stations, but transmitting the information only once.

Three bits in the Routing Control Field of each frame indicate:

- Whether the frame is broadcast or non-broadcast
- For broadcast frames, which type of broadcast is used:
  - *All-routes broadcast* indicates that the frame is to be sent to all LAN segments in the network (across all bridges, even if multiple paths allow multiple copies of the message to arrive at some LAN segments).
  - *Single-route broadcast* indicates that a frame is to cross only bridges that are configured to forward single-route broadcast frames. This provides a way of making sure that only one copy of a single-route broadcast frame arrives at each LAN segment.

    The program that generates a frame designates it as a single-route broadcast frame. A program might use single-route broadcast frames to discover the route between its own station and a station on another LAN segment in a multi-segment network. Then, the program or interface can communicate with the other station directly, specifying in the frames it sends the bridges that a frame must cross to reach the other station. (This is called *source routing*.)

Note: Broadcast frames intended for every *station* on the network (all-station broadcast) have a destination address of all ones.

Single-Route Broadcast and Source Routing Bridges

Bridging products that use source routing can use configuration parameter values to control the transmission of single-route broadcast traffic across the network. Only bridges that have been configured with single-route broadcast active will pass such frames from one LAN segment to another. All non-broadcast traffic and all other broadcast traffic on the network is unaffected.

Single-route broadcast must be active or inactive on the bridges in the network to create a single path between any two LAN segments in the network for single-route broadcast transmission, and to thereby prevent multiple copies of the same single-route broadcast transmission from reaching any LAN segment.

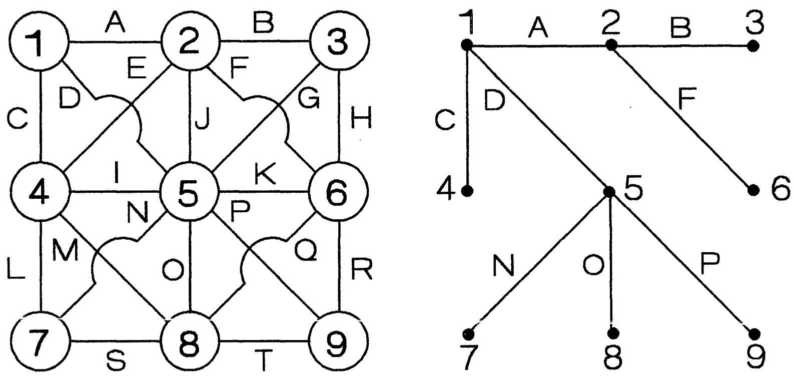
For two LAN segments joined by parallel bridges, only one of the bridges should allow single-route broadcast traffic to cross from one LAN segment to the other.

Single-Route Broadcast — Manual Mode

The IBM bridging products discussed in this publication that connect to the IBM Token-Ring Network provide the manual mode of single-route broadcast. (In the IBM Token-Ring Network Bridge Program Version 1.1, manual mode is the only mode provided.)

You must set the parameters in the configuration file for each bridge individually to make single-route broadcast active or inactive for each bridge. Before setting the parameters values, you must determine which bridges need single-route broadcast active.

To determine which bridges need single-route broadcast active, you can draw a diagram like the one in Figure 15-2. The illustration on the left side of the figure shows a nine-segment, mesh network. The diagram on the right is the planner's determination of which bridges should have single-route broadcast active.



Letters = Bridges
Numbers = LAN segments

Figure 15-2. Single-Route Broadcast Bridges

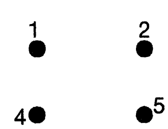
To prepare a similar diagram, follow the steps below:

1. Starting with any LAN segment, make a dot that represents that LAN segment and label it with the LAN segment number.

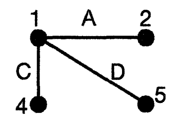
   The diagram in Figure 15-2 began with LAN segment 1.

2. Make a dot for each LAN segment to which the first LAN segment is connected by a bridge. Label each new dot with its LAN segment number.

   In Figure 15-2, LAN segment 1 connects to LAN segments 2, 4, and 5.

3. Draw a line from the dot for LAN segment 1 to each new dot; each line indicates a bridge. Label each line with the bridge identifier.

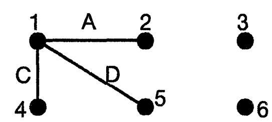
   

   In Figure 15-2, bridges A, C, and D connect LAN segment 1 to LAN segments 2, 4, and 5 respectively.

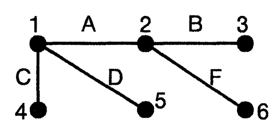
4. Taking each new dot in turn, make a dot for each LAN segment connected to it in the network that is not already shown in the diagram. Label each dot with the LAN segment number. Connect the dots with lines representing bridges; label the lines with the appropriate bridge identifiers.

   In the example:

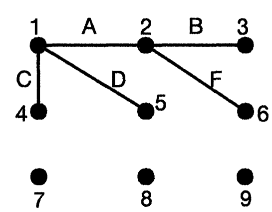
   a. In Figure 15-2, LAN segment 2 connects to LAN segments 1, 3, 4, 5, and 6. Add dots for LAN segments 3 and 6; LAN segments 4 and 5 already appear on the diagram

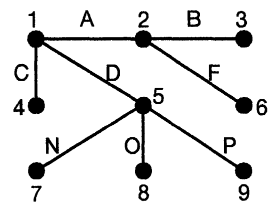
   b. In Figure 15-2, bridges B and F connect LAN segment 2 to LAN segments 3 and 6 respectively. Draw and label the lines for bridges B and F.

   c. In Figure 15-2, LAN segment 5 connects to LAN segments 1, 2, 3, 4, 6, 7, 8, and 9. Add and label dots for LAN segments 7, 8, and 9; the other LAN segments already appear in the diagram.

d. In Figure 15-2, bridges N, O, and P connect LAN segment 5 to LAN segments 7, 8, and 9 respectively. Draw and label the lines for bridges N, O, and P.



e. In Figure 15-2, LAN segment 4 connects to LAN segments 1, 2, 5, 7, and 8. No new dots or lines are needed; all of these LAN segments already appear in the diagram.

This completes the example; all the LAN segments now appear on the diagram.

Each bridge shown in the completed example should have the single-route broadcast function active. The number of bridges with the single-route broadcast function active is always equal to one less than the total number of LAN segments in the network.

While this procedure automatically takes care of parallel bridges, you should make sure that in all cases of parallel bridges, only one of the parallel bridges between two LAN segments has single-route broadcast active.

This procedure must be repeated each time:

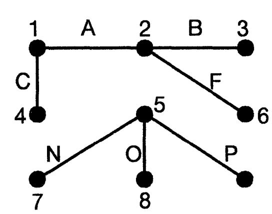
- A bridge is added to or removed from a LAN
- The single-route broadcast parameter setting is changed for any bridge in the network.

A bridge can communicate concurrently with up to four network manager programs. The network manager program designated as the *controlling* network manager for a bridge can change the setting of that bridge's single-route broadcast parameter,

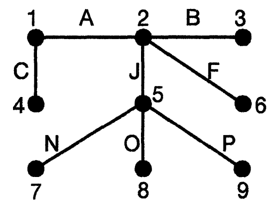
If you change one bridge's single-route broadcast parameter, you must repeat the procedure to redraw the diagram for the entire network and determine which other bridges also need the single-route broadcast parameter changed. Otherwise single-route broadcast communication between portions of the network will be either disconnected where it is needed or connected where it should not be.

In the completed example shown on page 15-9:

If the single-route broadcast parameter is changed to inactive for bridge D or bridge D is not operating in the network, the diagram changes to the one shown at the right. Bridge D is no longer shown.



Bridge J must have its single-route broadcast parameter changed to active to maintain single-route broadcast communication over all nine LAN segments. Bridge J is added to the diagram.



Thus, care must be taken to preserve a single path for single-route broadcast transmission between any two LAN segments in the network when adding bridges, removing bridges, or changing bridge single-route broadcast parameter settings.

Single-Route Broadcast — Automatic Mode

The IBM 8209 with the token-ring attachment module, the IBM PC Network Bridge Program, and the IBM Token-Ring Network Bridge Programs later than Version 1.1 provide automatic single-route broadcast (Version 1.1 does not).

You can configure the bridges to perform the following actions automatically and dynamically:

- Communicate with the other bridges in a network to determine which bridges should have single-route broadcast active and which should not.
- Set the single-route broadcast configuration parameters for each bridge so that there is always a single path for single-route broadcast frames between any two LAN segments in the network.

Bridge Roles

In a network using automatic single-route broadcast, each bridge assumes one of three roles:

- The root bridge
  - There is at any one time only one root bridge in the network.
  - The root bridge should be in a central location in your network in order to provide the shortest paths to all connecting LAN segments.
  - The root bridge is the active bridge with the lowest bridge ID in the network.
  - The responsibility of the root bridge is to send a "hello" message (containing its bridge ID, a path cost of zero, and timing information) every 2 seconds on both LAN segments to which it is connected.
  - The root bridge has single-route broadcast set to active in both directions.

- A designated bridge
  - A designated bridge has single-route broadcast active in both directions.
  - A bridge is a designated bridge when it:
    - Is not parallel to any other bridge (and is not the root bridge)
    - Is the only bridge of two or more parallel bridges that has single-route broadcast active
    - Is the only bridge at the end of two or more parallel paths between two LAN segments that has single-route broadcast active.
  - The responsibility of a designated bridge is to recognize and receive "hello" messages from the root bridge, update the path cost and timing information in each message, and forward the "hello" messages to its other LAN segment.
- A stand-by bridge
  - A stand-by bridge has single-route broadcast inactive in both directions; it cannot forward single-route broadcast frames.
  - The responsibility of a stand-by bridge is to monitor, but not update and forward, the "hello" messages. As bridges enter and leave the network, a stand-by bridge may need to assume the role of designated or root bridge and begin forwarding single-route broadcast frames. The "hello" message will indicate when this is necessary.
  - A stand-by bridge is directly parallel to a designated or root bridge, or is at the end of a path that is parallel to a path that has a designated bridge at the end.

The bridge uses bridge ID, path cost, and timing information to do the following:

- Determine which role a newly active bridge should assume
- Determine whether a bridge is a parallel bridge or in a parallel path
- Determine which one of two or more parallel bridges should have single-route broadcast active
- Detect when the root bridge or a designated bridge has left the network
- Reassign the bridge roles as necessary when bridges enter and leave the network.

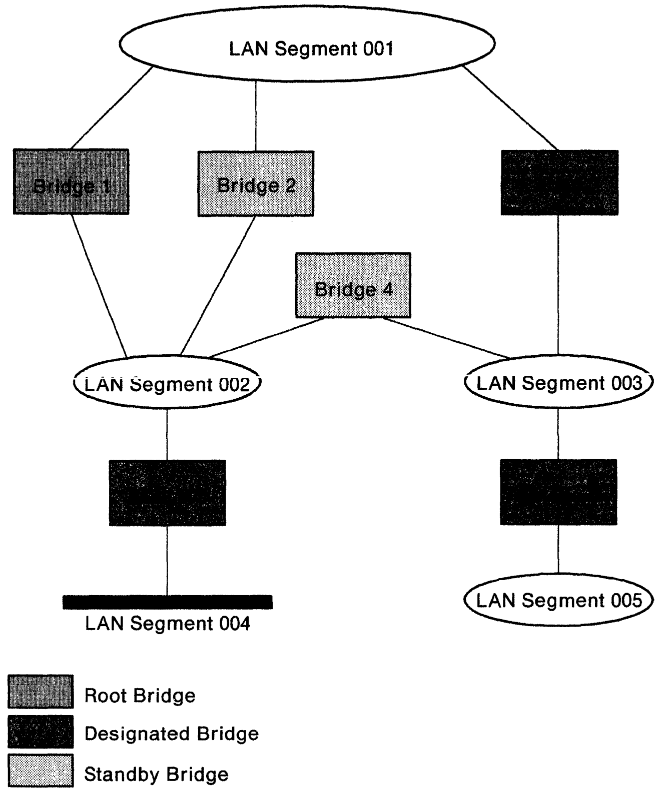


Figure 15-3. Automatic Single-Route Broadcast—Local Bridges

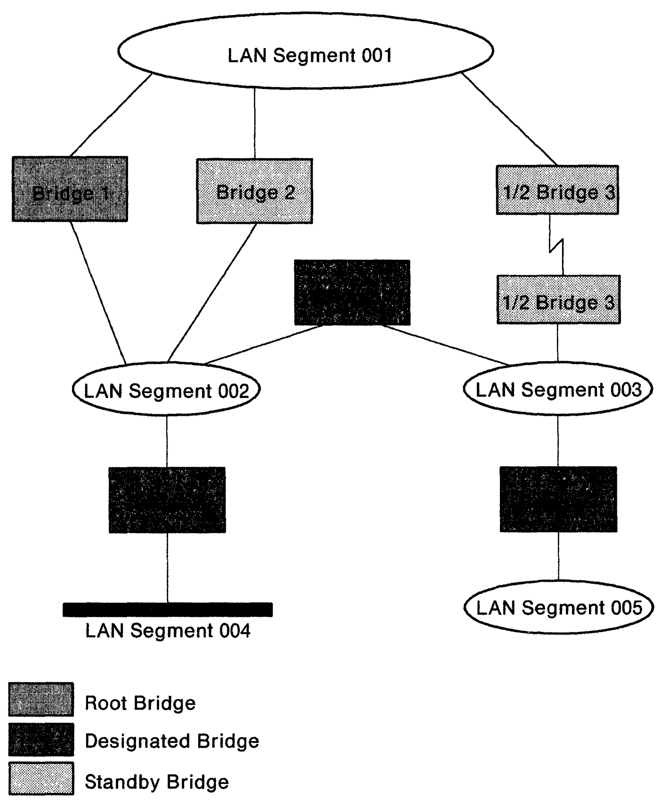


Figure 15-4. Automatic Single-Route Broadcast—With the Remote Bridge Function

Automatic Single-Route Broadcast Examples
Example 1 — Local Bridges
Figure 15-3 shows that you can assign bridge IDs and path cost increments so that when all bridges are active, each bridge plays a specific role. This is how it works:

- Assigning the lowest bridge label to bridge 1 causes bridge 1 to become the root bridge (the active bridge with the lowest bridge ID).
  - Bridge 2, which is parallel to the root bridge, becomes a stand-by bridge.
  - Bridge 3 becomes a designated bridge.
- Assigning a high path cost increment to bridge 4 causes bridge 4 to become a stand-by bridge.

  LAN segments 002 and 003 each can be reached by two paths from the root bridge. (In this example, bridge 2 is always a stand-by bridge unless bridge 1 is not active.) LAN segment 002 can be accessed through the root bridge directly, or through bridges 3 and 4. A high path cost at bridge 4 causes the path through the root bridge to have the lowest path cost. Similarly, LAN segment 003 can be accessed through bridge 3 directly, or through bridges 1 and 4. A high path cost increment at bridge 4 causes the path through bridge 3 to have the lowest path cost. Bridge 4 will not be a designated bridge in this network unless either bridge 3 is not active or bridges 1 and 2 are both not active.

  - Bridge 5 becomes a designated bridge. It is the only path to LAN segment 004.
  - Bridge 6 becomes a designated bridge. It is the only path to LAN segment 005.

Example 2 — The Remote Bridge Function
Figure 15-4 shows another way to assign bridge IDs and path cost increments so that when all bridges are active, each bridge plays a specific role. This is how it works:

- Assigning the lowest bridge label to bridge 1 causes bridge 1 to become the root bridge (the active bridge with the lowest bridge ID).
  - Bridge 2, which is parallel to the root bridge, becomes a stand-by bridge.
- Assigning a high path cost to bridge 3 (a bridge using the remote bridge function) causes bridge 3 to become a stand-by bridge.

  In most cases you probably will not want a bridge that uses the remote bridge function to act as the root bridge or a designated bridge, particularly if the telecommunications link between the bridge halves uses a lower line data rate. If other critical bridges in the network are not active or if the bridge using the remote bridge function is the only path to a LAN segment, then that bridge should have single-route broadcast active. However, you might want to set the single-route broadcast parameters for such a bridge manually as required.

- Assigning a low path cost increment to bridge 4 causes bridge 4 to become a designated bridge. Since bridge 3 is a stand-by bridge, bridge 4 becomes the single-route broadcast path to LAN segment 003.

  LAN segments 002 and 003 each can be reached by two paths from the root bridge. (In this example, bridge 2 is always a stand-by bridge unless bridge 1 is not active.) LAN segment 002 can be accessed through the root bridge directly, or through bridges 3 and 4. A high path cost at bridge 3 causes the path through the root bridge to have the lowest path cost. Similarly, LAN segment 003 can be accessed through bridge 3 directly, or through bridges 1 and 4. A low path cost increment at bridge 4 and a high path cost increment at bridge 3 cause the path through bridge 3 to have a higher path cost than the longer (but probably faster) path through bridges 1 and 4.

  - Bridge 5 becomes a designated bridge. It is the only path to LAN segment 004.
  - Bridge 6 becomes a designated bridge. It is the only path to LAN segment 005.

Bridge ID
Each bridge has a **bridge ID** that is recognized by the bridge's automatic single-route broadcast function. The bridge ID consists of:

- A 2-byte **bridge label**, for which you can assign a value or use the default value during the bridge program configuration
- The **adapter address** of the bridge adapter connected to the LAN segment with the lowest LAN segment number.

  The adapter addresses can be universally or locally administered addresses.

Automatic single-route broadcast uses the bridge ID to decide which parallel bridge should be the root bridge or a designated bridge (should have single-route broadcast active).

- The parallel bridge with the lowest bridge label will be the root or designated bridge.
- If the bridge labels are the same for two or more parallel bridges, (you either used the default value of X'8000' for more that one of the parallel bridges or assigned the same bridge label to more than one of the parallel bridges), automatic single-route broadcast uses the adapter address in the bridge ID to select the designated or root bridge from two or more parallel bridges.

Consider the following in using the default or assigning a value for a bridge label:

- To make sure that one particular parallel bridge is always selected as the root bridge or a designated bridge, assign a lower two-byte bridge label to that bridge than you assign to the other bridge(s) parallel to it.
- To make sure that a certain parallel bridge is selected as the root bridge or a designated bridge ONLY if all the other parallel bridges are not active, assign the highest bridge label to that bridge.

Path Cost
Each bridge also maintains a value called **path cost**, which indicates the relative length of the path between a bridge and a centrally-located bridge (the *root bridge*).

During bridge configuration, you can assign a value or use the default value for a bridge's path cost increment. The bridge programs choose a default path cost increment for a bridge based on:

- The types of network adapters installed in the bridge computer for a bridge using the local bridge function. (See Table 15-1.)
- A base cost and the line data rate, for a bridge using the remote bridge function. (See Table 15-2.)

  (The IBM 8209 bridge chooses a default path cost based on ring speed.)

Table 15-1. Path Cost Increment Default Values for Local Bridge Function

	Adapter II (4 Mbps) Adapter/A (4 Mbps)	**16/4 Adapter (4 Mbps) 16/4 Adapter/A (4 Mbps)**	**16/4 Adapter (16 Mbps) 16/4 Adapter/A (16 Mbps)**
Adapter II (4 Mbps) Adapter/A (4 Mbps)	16	40	34
16/4 Adapter (4 Mbps) 16/4 Adapter/A (4 Mbps)	40	64	40
16/4 Adapter (16 Mbps) 16/4 Adapter/A (16 Mbps)	34	40	16

Table 15-2. Path Cost Increment Default Values for Remote Bridge Function

Line Data Rate	**Default Value in Milliseconds**
9.6 Kbps	940
19.2 Kbps	870
56 Kbps	824
64 Kbps	821
1.344 Mbps	801

Each bridge's path cost is equal to the sum of the path cost increments of the bridges between it and the root bridge, plus its own path cost increment. The path cost for the root bridge is zero.

Automatic single-route broadcast uses the path cost to choose the shortest parallel path between two LAN segments (the path with the lowest path cost) for the single-route broadcast path.

You can influence the choice by the values you assign to the path cost increment for each bridge in the paths. For example, you may have two parallel paths to a LAN segment in your network, and the longer path uses more powerful (faster) bridge computers or contains LAN segments with faster data rates than the shorter path. If you want single-route broadcast frames to travel the longer path instead of the shorter one, assigning a very large path cost increment to one or more bridges in the shorter path will cause its last bridge to become a stand-by bridge. The last bridge in the longer path will become a designated bridge. The stand-by bridge in the shorter path would become a designated bridge only if one or more bridges in the longer path leave the network.

Other Considerations

To use automatic single-route broadcast in your network, you will need to consider the following:

- Automatic mode, manual mode and non-automatic bridges

  If you use bridges in your network that do not provide the automatic single-route broadcast function, you should use manual mode for all bridges in the network and individually set the single-route broadcast parameters for each bridge.

  - The non-automatic bridges will not be able to send or receive "hello" messages.
  - The automatic mode bridges will not recognize the presence of the non-automatic bridges in the network.
  - There is the probability of creating either multiple single-route broadcast paths between LAN segments or having no single-route broadcast path between LAN segments if an automatic mode bridge changes its single-route broadcast parameter settings.

  If your network contains only bridges that use local bridge function, a similar result can occur if some bridges are set to automatic and some are set to manual in the same network. If all of the bridge programs in your network provide automatic single-route broadcast, then all bridges should be set the same way — either all automatic or all manual.

  If your network contains one or more bridges that use the remote bridge function, you may not want a bridge using the remote bridge function to participate in the automatic single-route broadcast process with other bridges in the network. See the special considerations under "The remote bridge function" on page 15-17.

- The IBM LAN Manager

  The IBM LAN Manager Version 2.0 can change the bridge parameter settings to select automatic or manual single-route broadcast mode and to make single-route broadcast active or inactive.

  The IBM LAN Manager Version 1.0 can change only the parameter values to make single-route broadcast active or inactive in manual mode. The single-route broadcast selection mode must be set to manual before the IBM LAN Manager Version 1.0 can change the active/inactive setting.

  If you are using automatic single-route broadcast in your network, using the IBM LAN Manager to change single-route broadcast settings may disrupt the automatic single-route broadcast process. You may need to reevaluate and change single-route broadcast parameter settings manually throughout the network.

- Path cost and bridge ID

  The bridge tries to assign as designated bridges those on the shortest path between LAN segments (lowest path cost), and those with the lowest bridge ID (for parallel bridges). The root bridge will always be the active bridge with the lowest bridge ID.

  By assigning bridge labels and path cost increments with the selection rules in mind, you, as network administrator, can determine which bridges will be selected as root and designated bridges.

  - The time required for a single-route broadcast frame to travel from one end of a path to the other is affected by bridge program processing time, adapter type, LAN segment data rate, and type (processing power) of bridge computer. You need to consider all of these factors when assigning bridge labels and path cost increments. See "Bridge Performance Considerations" on page 13-36 for additional information.

- The remote bridge function

  When you use the remote bridge function of the Bridge Program and the bridge is in the only path between two LAN segments, you should set single-route broadcast to manual mode and active for the bridge using the remote bridge function. The bridge will not need to expend resources participating in the automatic single-route broadcast process. Other bridges in the network can still use automatic single-route broadcast.

  When you use the remote bridge function and the bridge is in one of two or more parallel paths between two LAN segments, you may not want the bridge to use automatic single-route broadcast. You may want to be sure that either the bridge using the remote bridge function is never a designated bridge or it is always a designated bridge, depending on your network characteristics.

Transparent Bridging Spanning-Tree Protocol

Transparent bridging requires that there be only one path between any two stations in the network configuration. Otherwise, the frames can loop and stay in the network permanently, causing network bandwidth to be wasted and often causing the network to fail.

A spanning-tree protocol for transparent bridging results in a loop-free network configuration. By enabling and disabling the ability of a bridge to forward frames to the other network, this protocol ensures dynamically that there is only one active bridge between any two LAN segments in the entire transparent bridging network.

The spanning-tree protocol implemented by IBM for transparent bridging uses parameters similar to those for single-route broadcast to determine which bridges are the root bridge, designated bridges, and blocked bridges. The protocol includes the use of "hello" messages to detect changes in active bridges in the network, and the use of bridge identifiers and path cost information to determine which one of two or more parallel bridges is active.

Note: The IBM 8209 in an Ethernet environment always acts as a single-route broadcast bridge in the token-ring domain. The IBM 8209 incorporates transparent bridging for use with the attachment module that supports Ethernet and IEEE 802.3 LANs.

Using Early Token Release with Bridges

Early Token Release is an adapter configuration option used only in 16 Mbps IBM Token-Ring Network segments, to allow network adapters more frequent access to a token.

See "Data Transmission" on page 2-10 for more information about Early Token Release.

In deciding whether to set Early Token Release on or off for the bridge adapters, consider the following:

- On a LAN segment connected to a bridge, if there are programs that **must** use a higher priority to acquire tokens more frequently than other programs, then Early Token Release must be set OFF for all adapters on the LAN segment, including the bridge adapter.
- If priority token access is not required by the programs on the LAN segment, then Early Token Release can be set ON for all adapters on the LAN segment, including the bridge adapter.
- Though some programs written to run on the IBM Token-Ring Network do set a higher than normal priority (the Bridge Program does), most of these programs should function normally with Early Token Release active.
- You will need to determine whether there are any programs that require priority token access on the LAN segments connected to the bridge adapters, and set Early Token Release accordingly for all of the adapters on the LAN segment.

Planning for Bridging Programs in a Network

Each bridge adapter attaches its bridge station to a LAN segment. The adapter cable for each bridge adapter must be able to reach a connection point to the appropriate LAN segment. Therefore, the two connection points for bridges using local bridge function must be located near each other and near the bridge device. Each station of a bridge using remote bridge function must be near its access unit and near the telecommunications link connection point. See Chapter 8, "Network Planning" for more information about using bridges to connect LAN segments in a network.

IBM bridging products that provide *local* bridge function require a dedicated workstation in which are installed two network adapters or features that provide adapter function.

IBM bridge programs that provide *remote* bridge function require a dedicated workstation (selected models of IBM Personal Computers or IBM Personal System/2 computers) at each end of a telecommunications link. Each workstation has a network adapter and a communication adapter installed.

As well as providing the means to transfer data between two LAN segments, most IBM bridging products provide:

- LAN segment status and error information (similar to that supplied by the IBM Token-Ring Network Ring Diagnostic and the IBM LAN Manager) that can be used for problem determination
- Bridge performance information that can help you evaluate and manage traffic flow through the bridge
- Function to allow up to four network management programs (such as the IBM LAN Manager or the LAN Network Manager) to establish links with the bridge, over which the bridge can send LAN segment status, adapter status, error information, and bridge performance information to the network management programs
- A self-test to see that the bridge is able to send and receive data on and across both LAN segments.

Bridge Definition and Documentation

As the network administrator or planner, you fill in copies of charts and worksheets specifying the values to use for the definition, installation, and configuration parameters for each bridge in your network. The completed charts are used for hardware and software installation and for problem determination.

Bridge Planning Charts

The Bridge Planning Charts provide the means for you to record the information that is needed to install and configure each bridge in your network.

One section of each Bridge Planning Chart shows the physical location of the bridge in your network. The remaining sections contain spaces in which you write the installation and configuration parameter values to use when installing the bridge.

To complete the Bridge Planning Charts, refer to:

- The *User's Guide* for the appropriate bridge program, for parameter descriptions, valid values, and allowable ranges
- The *Customer Information* and each *Attachment Module Guide* for the IBM 8209
- This chapter for information on determining the values for parameters that affect network data flow and network management (locally administered addresses, single-route broadcast, and server functions, for example)
- The *IBM Token-Ring Network Introduction and Planning Guide* for information on physical placement and labeling of the bridge hardware and cable connections in an IBM Token-Ring Network
- The *Planning Guide* for the IBM PC Network Broadband and IBM PC Network Baseband and your professional network planner/installer for layout and labeling information for an IBM PC Network.

When you have finished filling in each Bridge Planning Chart, give a copy to the persons who will install the bridge hardware and prepare the working disk or diskette. If you are using the remote bridge function, you need to make two copies of the completed Bridge Planning Chart: one copy for each station connected by the telecommunications link. Part of the bridge installation for the remote bridge function must be done at each bridge half. File the completed charts with the other permanent records for your network.

Note: Be sure to use the correct version of the charts and instructions for your bridge program. Use only the Bridge Planning Charts and information about filling in each chart found in the *Attachment Module Guide* or *User's Guide* and the *Administrator's Guide* that apply to the bridge you are installing. Versions of the chart and instructions found in early editions of the *IBM Token-Ring Network Administrator's Guide* and the *IBM Token-Ring Network Introduction and Planning Guide* apply only to specific early versions of IBM bridge programs.

IBM LAN Manager Worksheets

"Using Bridging Products with the IBM LAN Manager and the IBM LAN Network Manager" on page 15-20 describes the use of worksheets to define each bridge to each IBM LAN Manager or LAN Network Manager with which the bridge can communicate.

Network Documentation

In addition to completing each Bridge Planning Chart and IBM LAN Manager or IBM LAN Network Manager worksheet, you should add certain information to your other network records. Record the physical connections points, station locations, labeling information, and adapter addresses for each bridge on the appropriate charts and floor plans.

Using Bridging Products with the IBM LAN Manager and the IBM LAN Network Manager

Each IBM bridge can communicate with up to four IBM LAN Manager or IBM LAN Network Manager stations (or other network management programs). The IBM LAN Manager or IBM LAN Network Manager using Link 0 is the *controlling* LAN Manager or IBM LAN Network Manager, which is allowed to change bridge configuration parameters and communicate bridge information to NetView at a host. An IBM LAN Manager or IBM LAN Network Manager program using Link 1, 2, or 3 to link to a bridge (*observing* IBM LAN Manager or IBM LAN Network Manager stations) can receive status and error information from the bridge but cannot change bridge configuration parameters or communicate with NetView about the bridge.

A network can have more than one controlling IBM LAN Manager or IBM LAN Network Manager as long as the controlling IBM LAN Managers or IBM LAN Network Managers do not try to communicate with the same bridges.

Each IBM LAN Manager or IBM LAN Network Manager that can communicate with a bridge must use a different one of the four communication links to the bridge.

Bridge Definition and System Definition Worksheets
For each bridge that links to the IBM LAN Manager, there are worksheets on which to provide the information needed to define the bridge to the IBM LAN Manager or IBM LAN Network Manager during installation and configuration:

In filling in the worksheets, certain bridge and system definition parameters must agree with the corresponding values specified in the bridge configuration. Generally:

- The bridge number and LAN segment numbers specified in the bridge definition must match those specified in the Bridge Planning Chart for the same bridge.

  For the IBM LAN Manager Version 2.0, the adapter address for each bridge adapter must be specified in the IBM LAN Manager Bridge Definition. The bridge number and LAN segment number can be defined automatically when the link with the bridge is established.

- Bridge-related fields in the system definition specify the link number and password for the communication link that is used to communicate with bridges.

  A single IBM LAN Manager or IBM LAN Network Manager can define only one communication link number and associated link password at a time. That link number and password are used for **all** of the bridges with which it can communicate. The link number automatically defines the IBM LAN Manager or IBM LAN Network Manager as controlling (Link 0) or observing (Links 1, 2, and 3).

  On the Bridge Planning Chart for every bridge that communicates with the same IBM LAN Manager or IBM LAN Network Manager, you must assign the same link password to the link number used by that IBM LAN Manager or IBM LAN Network Manager, and use that password for the link during system definition.

Refer to the appropriate IBM LAN Manager or LAN Network Manager *User's Guide* for blank originals of the worksheets and for descriptions of the fields and parameters.

When you have completed the worksheets, give a copy to the person installing the IBM LAN Manager or LAN Network Manager, and file a copy with the permanent records for your network. Update the worksheets as changes are made to the IBM LAN Manager or LAN Network Manager and bridges in your network.

IBM LAN Manager Versions 1.0 and 2.0 and the IBM LAN Network Manager vary in their capability to change bridge configuration parameter values and to receive information for multiple LAN segments through and from bridges.

For example:

- The IBM LAN Manager Version 1.0 can receive information for:
  - Multiple IBM Token-Ring Network segments from up to 32 bridges
  - An IBM PC Network segment only if the IBM LAN Manager is attached to that segment.

  For more information about this version of the IBM LAN Manager:
  - Refer to the *IBM LAN Manager User's Guide* for Version 1.0
  - See Chapter 14 of this manual.
- The IBM LAN Manager Version 2.0 can receive information for multiple IBM Token-Ring Network segments and multiple IBM PC Network segments. A single IBM LAN Manager can communicate with up to 64 bridges.

  For more information about this version of the IBM LAN Manager, refer to the *IBM LAN Manager Version 2 User's Guide* and Chapter 14 of this manual.

Changing Bridge Program Configuration Parameters
If you are using the IBM LAN Manager Version 1.0 in your network, you can use the controlling IBM LAN Manager station to change **only** the single-route broadcast bridge program configuration parameters for a bridge (to make single-route broadcast active or inactive). You **cannot** change any other bridge configuration parameter using this version of the IBM LAN Manager.

When the IBM LAN Manager Version 1.0 changes the single-route broadcast parameter values of the bridge, the changed values are permanently recorded at the bridge.

If you are using the IBM LAN Manager Version 2.0 in your network, you **can** change the following bridge program configuration parameters from the controlling LAN Manager station:

- Bridge number
- LAN segment numbers
- Frame forwarding active
- Bridge performance threshold (the IBM LAN Manager calls it the Percent frames lost threshold, expressed as a percent instead of a number of frames)
- Hop count limit
- Single-route broadcast (selection mode and parameter values)
- Link passwords.

Bridge configuration parameter values changed by the IBM LAN Manager are permanently recorded at the bridge.

If the controlling IBM LAN Manager or IBM LAN Network Manager Version 1.0 linked to a bridge also communicates with NetView, the NetView operator can send SPCS commands to do the following:

- Change the previously listed bridge program configuration parameters
- Establish and disconnect the communication link between the IBM LAN Manager and the bridge program

- Display at NetView the bridge profile and bridge performance counters for the bridge
- Request a path test and LAN segment test
- Remove an adapter from active participation on the network.

Bridge Performance Analysis
The IBM LAN Manager Version 1.0 **Bridge Profile** function includes a display of the bridge performance counters that help you evaluate bridge traffic flow.

The IBM LAN Manager Version 2.0 provides two ways to obtain and use bridge performance counters to help you evaluate bridge traffic flow:

- The **Bridge Profile** function includes a display of the bridge performance counters. "Bridge Performance Analysis" on page 13-6 describes worksheets and instructions for using the bridge performance counters for bridge performance analysis.
- When you use the **Configure Bridge** function to specify a non-zero Performance notification interval, the bridge sends the performance counter values to the IBM LAN Manager each time that interval (in minutes) elapses. The IBM LAN Manager records the values in a counter file on fixed disk.

  "Bridge Performance Analysis" on page 13-6 explains how to write a program to analyze the counter values recorded in the file to evaluate bridge traffic flow.

  The IBM LAN Network Manager provides the bridge profile display of the counters, records counter values in the Bridge Performance Table (instead of the counter file), does some performance analysis calculations for you, and includes support for additional NetView SPCS commands.

Bridge Parameters

As the network administrator or planner, you must coordinate the selection of values for all configuration and installation parameters for the bridging products in your network.

- All of the IBM bridging programs use a configuration file to define bridge parameter values. (The IBM 8209 bridge stores configuration parameters in NVRAM.)
- The IBM Token-Ring Network Bridge Program Versions 2.0 and later and the IBM PC Network Bridge Program allow the user to define installation parameters that specify values for network and network adapter configuration.
- The IBM Token-Ring Network bridging products that provide the remote bridge function require the user to define communication adapter parameter values. (Most of these parameters do not have default values; the user must specify a value.)

Bridge Program Function

The following table summarizes the functions supported by different versions of the Bridge Program.

Functional highlights of IBM Token Ring Bridge Program Versions 1.1, 2.0, 2.1, and 2.2.

Table 15-3. Bridge Program Function Summary

	1.1	**2.0**	**2.1**	**2.2**
Local TRN-TRN Bridge	Yes	Yes	Yes	Yes
Communication with LAN management applications (up to four)	Yes	Yes	Yes	Yes
Single Route Broadcast - Manual	Yes	Yes	Yes	Yes
Single Route Broadcast - Automatic	No	Yes*	Yes	Yes
Bridging of different TRN Adapters (4Mbps to 4Mbps, 4Mbps to 16Mbps, 16Mbps to 16Mbps)	No	Yes	Yes	Yes
Filters	No	No	Yes	Yes
Remote TRN-TRN Bridge	No	No	Yes	Yes
Remote Dial Feature	No	No	No	Yes

Note: * PTF UR25531 or later.

The IBM Token-Ring Network Bridge Program (Version 1.1)

The IBM Token-Ring Network Bridge Program Version 1.1 joins together two rings of an IBM Token-Ring Network, permitting communication between devices connected to different rings.

The IBM Token-Ring Network Bridge Program Version 1.1 requires a dedicated workstation (referred to in this discussion as the bridge computer), with two IBM Token-Ring Network adapters of the same type installed. The bridge computer is an attaching device on a lobe of each ring. The adapter cable for each bridge adapter must be able to reach an access unit connected to the appropriate ring. Therefore, the two access units must be located near each other and near the bridge device.

The Bridge Program uses source routing to transfer data between two rings of an IBM Token-Ring Network. Devices which support source routing can communicate through the bridge, even though they are attached to different rings.

As well as providing the means to transfer data between two rings, the Bridge Program provides:

- Ring status and error information (similar to that supplied by the Ring Diagnostic and the IBM LAN Manager) that can be used for problem determination
- Bridge performance information that can help you evaluate and manage traffic flow through the bridge
- Function to allow up to four network manager programs (such as the IBM LAN Manager) to establish links with the Bridge Program, over which the Bridge Program can send ring status, adapter status, error information, and bridge performance information to the network manager programs
- A self-test to see that the bridge is able to send and receive data on and across both rings.

Bridge Program (Version 1.1) Configuration Parameters

Some parameters that define functions of the bridge are set in a configuration file before the Bridge Program is loaded. A configuration file provided on the diskette with the Bridge Program contains default parameters. A Configuration Program, supplied on the diskette with the Bridge Program, helps you alter the default values to meet the needs of your network.

The person preparing each Bridge Program working disk or diskette for your network will ask you or the network planner to provide a completed copy of the Bridge Planning Chart (see the *IBM Token-Ring Network Bridge Program User's Guide*), indicating any changes to the bridge configuration parameters. Once set, the configuration parameters can be permanently changed only by using the Configuration Program to alter the file again and restarting the Bridge Program.

The bridge configuration parameters include some adapter configuration parameters usually specified in the IBM LAN Support Program configuration (shared RAM address and locally administered address). The Bridge Program contains its own adapter support code, and does not require the IBM LAN Support Program.

The bridge configuration parameters are:

- Bridge number

  Each bridge is assigned a number that will be used for routing frames. Multiple (parallel) bridges joining the same two rings must not duplicate a bridge number.

- Ring numbers

  Each ring that is connected by a bridge is assigned a ring number, which must be unique across the network. This parameter indicates to each adapter the number of the ring to which it is attached.

- Frame forwarding active

  This parameter indicates whether the Bridge Program is to begin passing frames through the bridge as soon as initialization is complete, or is to wait until a network manager program establishes a link with the bridge and turns on frame forwarding. (The IBM LAN Manager Version 1.0 does not contain function to turn bridge frame forwarding on and off; the IBM LAN Manager Version 2.0 and the IBM LAN Network Manager do provide this function.)

- Bridge performance threshold

  This parameter sets the maximum number of frames that are not forwarded through the bridge, per 10,000 frames received at the bridge, before the Bridge Program counts a "threshold exceeded" occurrence in the performance statistics and notifies any linked network manager programs.

  You may need to adjust the bridge performance threshold value over time to provide a better correlation between the occurrence of the threshold being exceeded and user perception of a problem in response time, data exchange, or application program operation.

  See "Bridge Performance Analysis" on page 13-6 for more information about determining the value to use for the Bridge performance threshold.

- Restart on error

  This function causes an automatic reloading of DOS and the Bridge Program into the computer if an adapter check or a critical resource depletion occurs. If this function is used, all of the commands necessary to load the Bridge Program must be contained in a DOS AUTOEXEC.BAT batch load file on the default drive. None of the commands can require operator intervention before the load continues (such as time or date requests). Automatic loading can be particularly useful if the device in which it runs is used only for the bridge (there would not be a need for conflicting AUTOEXEC.BAT files on the default drive, or a need for operator intervention at load time).

  Note: If you use both the Restart on error and Memory dump on error functions, the AUTOEXEC.BAT file must be located on the same drive specified for the Memory dump on error.

- Drive for memory dump on error

  If a Bridge Program internal program error occurs, the Bridge Program writes a file containing an image (dump) of itself and its buffers from computer memory onto the fixed disk or diskette drive specified by this parameter. There must be sufficient space on the specified disk or diskette for the dump file.

You will need to give instructions to the bridge operator for preserving the dump file and attempting to restart the Bridge Program:

  - You may need to give a copy of the dump file and a copy of your Bridge Program working disk or diskette to your service supplier if you cannot resolve the problem.
  - If the dump file is on the fixed disk or the Bridge Program working diskette, copy the file to a separate diskette before trying to restart the Bridge Program.
  - The last records in the ECCLOG.DAT file should indicate the reason for the termination of the Bridge Program.

- Drive for error log

  This parameter specifies the fixed disk or diskette drive to be used to log the messages generated when the Bridge Program terminates operation either by operator request or because of an adapter check or critical resource depletion.

  The error log file (ECCLOG.DAT) must be erased and the Bridge Program restarted to clear the file when it fills up. A text editor must be used to display the contents of the file.

- Hop count limit

  For each adapter, a hop count limit is entered. The hop count is the number of bridges that broadcast and single-route broadcast frames received from the ring attached to this adapter have already crossed. A frame whose hop count is equal to or higher than the receiving adapter's hop count limit is not permitted to cross the bridge.

- Single-route broadcast

  For each bridge adapter, the single-route broadcast function may be active or inactive. Only bridges that have been configured to have single-route broadcast active will pass single-route broadcast frames from one ring to another. All other broadcast traffic on the network is unaffected.

  See "Single-Route Broadcast" on page 15-6 for details on using the single-route broadcast bridge program parameters.

- Locally administered address

  This parameter allows you to assign a locally administered address to each bridge adapter, to override the universally administered address. Each locally administered address must be unique on the network.

- Ring parameter server

  This parameter specifies for each ring whether or not the ring parameter server functional address is enabled; that is, whether frames destined for this function will be copied by the Bridge Program.

  The ring parameter server provides the ring number to an adapter when the adapter is attaching to the ring, and sends a notification to one or more network manager programs when a new adapter has attached to the ring.

- Ring error monitor

  This parameter specifies for each ring whether or not the ring error monitor functional address is enabled; that is, whether frames destined for this function will be copied by the Bridge Program.

  The ring error monitor:

  - Compiles error statistics reported by adapters on either ring
  - Analyzes the statistics to determine a probable cause of errors degrading ring operation
  - Updates the ring status area of the Bridge Program panels to "Soft Error" when appropriate
  - Sends reports to indicate critical problems to the network manager programs that have requested reports.

  If the ring error monitor parameter value is **N** (No) for a ring, soft error information will not be displayed for that ring by the Bridge Program, and the ring status "Soft Error" will not be displayed on the Bridge Program panels when soft errors occur.

- Configuration report server

  This parameter specifies for each ring whether or not the configuration report server functional address is enabled; that is, whether frames destined for this function will be copied by the Bridge Program.

  The configuration report server sends notifications about the current active configuration of each ring to the network manager programs that request reports. Changes in nearest active upstream neighbor (NAUN) addresses and active monitor on the ring are reported.

- Shared RAM address

  This parameter defines for each adapter the location in computer memory to be used for the RAM shared by the computer and the adapter. A different address must be used for each adapter. The defaults are recommended unless there is a specific and critical need to use other addresses.

- Link passwords

  The Bridge Program uses these passwords to determine that an IBM LAN Manager or LAN Network Manager program is authorized to establish a communication link with the Bridge Program. The IBM LAN Manager and the IBM LAN Network Manager request and receive network management reports and notifications from the Bridge Program over the link. The controlling IBM LAN Manager or LAN Network Manager program (the program that established link 0) can change some Bridge Program configuration parameters in the bridge computer memory. Bridge configuration parameter values changed by the IBM LAN Manager are recorded in the ECCPARMS.BIN file.

  The IBM LAN Manager or LAN Network Manager program must give a valid password when it is establishing a link or the link request will be rejected. Note that if the link password is not changed from the default (which is "00000000") during Bridge Program configuration, the IBM LAN Manager or LAN Network Manager link must still specify that the password is "00000000".

  Up to four IBM LAN Manager or LAN Network Manager programs can concurrently establish a communication link with the Bridge Program. Each IBM LAN Manager or LAN Network Manager program must use a different one of the four link passwords.

  The completed Bridge Planning chart should show any link passwords used instead of the defaults. Give a copy of the passwords to the person doing configuration for the IBM LAN Manager or LAN Network Manager programs that will communicate with your bridge. Keep the Bridge Planning Chart in a secure place for future reference.

Bridge Program (Version 1.1) Output

The Bridge Program displays information about:

- Each ring connected to the bridge
- The adapters in the bridge computer
- The functioning of the Bridge Program itself
- Any links to network manager programs.

Panels contain the displayed information, and allow selection of Bridge Program functions.

The status of each of the two rings that are connected by the bridge is shown on the bottom line of the screen. The line above the ring status line indicates which function keys are currently active. The line above the function key indicators is used to display any messages that occur while the panel is being displayed. The center of the panel contains possible function selections, a display of information requested by the operator, or information to help you use the bridge functions.

Ring Status

The status of each of the two rings is shown on the bottom line of the screen, one on the left and one on the right:

Normal: The LAN segment is operating normally.

Adapter Closed: This IBM Token-Ring Network adapter used by the bridge is no longer logically attached to the LAN segment.

Soft Error: The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly.

Wire Fault: There is a problem between the bridge computer's network adapter and the access unit to which it is connected. The network adapter, the cable from the network adapter to the access unit, or the access unit could be the source of the problem. The network adapter in the bridge computer is closed.

Beaconing: The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating the network within a predefined time limit.

Ring status details can be requested and displayed on a panel. These details show the most recent soft error and beaconing condition for each ring. And they show the portion of the ring most likely to contain the error (the *fault domain*).

Bridge Program Status

The messages near the bottom of the screen and the information that can be displayed in the center of the panel include details about:

- The functioning of the Bridge Program and the bridge adapters
- The configuration parameter settings currently being used by the Bridge Program
- The traffic flowing through the bridge
- Links with network manager programs.

The bridge traffic information that can be displayed includes:

- The Path Trace Log

  Any frame passed across the bridge that has the system path trace request bit set on will cause an entry to be logged in the Path Trace Log. Entries can be displayed and cleared using the Bridge Program Path Trace panel.

- The performance counters and statistics

  The performance counters and statistics provide information about frames that are forwarded and not forwarded through the bridge.

  See "Bridge Performance Analysis" on page 13-6 for a description of the meaning and use of the Bridge Program performance information.

The IBM Token-Ring Network Bridge Program (Version 2.0)

The IBM Token-Ring Network Bridge Program Version 2.0 joins together two rings of an IBM Token-Ring Network, permitting communication between devices connected to different rings.

The IBM Token-Ring Network Bridge Program Version 2.0 requires a dedicated workstation (referred to in this discussion as the bridge computer), with two IBM Token-Ring Network Adapters installed. The bridge computer is an attaching device on a lobe of each ring. The adapter cable for each bridge adapter must be able to reach an access unit connected to the appropriate ring. Therefore, the two access units must be located near each other and near the bridge device.

The Bridge Program uses source routing to transfer data between two rings of an IBM Token-Ring Network. Devices which support source routing can communicate through the bridge, even though they are attached to different rings.

As well as providing the means to transfer data between two rings, the Bridge Program provides:

- Ring status and error information (similar to that supplied by the Ring Diagnostic and the IBM LAN Manager) that can be used for problem determination
- Bridge performance information that can help you evaluate and manage traffic flow through the bridge
- Functions to allow up to four network manager programs (such as the IBM LAN Manager) to establish links with the Bridge Program, over which the Bridge Program can send ring status, adapter status, error information, and bridge performance information to the network manager programs
- A self-test to see that the bridge is able to send and receive data on and across both rings.

In addition to the above functions, Version 2.0 of the Bridge Program provides:

- Support for two IBM Token-Ring Network adapters that are compatible with your bridge computer. These do not have to be the same type of adapter.
- Support for bridging two rings that are running at different data transfer rates. For example, a 4-Mbps ring and a 16-Mbps ring can be bridged.
- A spanning-tree protocol for automatic configuration of the single-route broadcast path.

During Bridge Program installation, you will need to specify values or use the default values for:

- Bridge program installation parameters
- Bridge program configuration parameters.

Note: The bridges do not support the IBM Token-Ring Network 16/4 Busmaster Server Adapter/A.

Bridge Program (Version 2.0) Installation Parameters

The bridge installation parameters include some adapter configuration parameters usually specified in the IBM LAN Support Program configuration. Because the Bridge Program contains its own adapter support code and does not require the Support Program, the following parameters must be specified during Bridge Program installation:

- Adapter name

  This parameter specifies the type of primary and alternate adapter installed in the bridge computer (for example, Adapter II, Adapter/A, or 16/4 Adapter).

- Adapter data rate

  This parameter specifies whether each ring operates at 4 or 16 Mbps.

- Locally administered address

  This parameter allows you to assign a locally administered address to each bridge adapter, to override the universally administered address. Each locally administered address must be unique on the network. See "IBM LAN Network Addressing" on page 1-25 for more about assigning locally administered addresses.

- Shared RAM address

  This parameter defines for each adapter the location in computer memory to be used for the RAM shared by the computer and the adapter. A different address must be used for each adapter. The defaults are recommended unless there is a specific and critical need to use other addresses.

  Each shared RAM address must be located on a 16-KB boundary and is dependent upon the options installed in your computer. Each adapter's shared RAM address must not conflict with any of the following addresses:

  - Shared RAM address of the other network adapter in the same bridge station
  - ROM address of this bridge adapter
  - ROM address of the other network adapter in the same bridge station

  If you have a specific need to use values other than the defaults, refer to the *IBM Token-Ring Network Bridge Program User's Guide* and:

  - For the IBM Token-Ring Network PC Adapter II and the IBM Token-Ring Network 16/4 Adapter, use the memory map in the adapter's *Guide to Operations* to select a value for this parameter.
  - For the IBM Token-Ring Network Adapter/A and the IBM Token-Ring Network 16/4 Adapter/A, use the configuration information on the computer's Reference Diskette to determine and set the shared RAM address for each adapter.

- Early Token Release

  Early Token Release is valid only for IBM Token-Ring Network adapters that support network data rates of both 4 and 16 Mbps as adapter configuration parameters. This option increases the utilization of the network by reducing the average time required for a network adapter to gain access to a token. It is automatically enabled when a 16/4 adapter's data rate is set to 16 Mbps. Early Token Release is ignored if the IBM Token-Ring Network segment operates at a data rate of 4 Mbps.

See "Using Early Token Release with Bridges" on page 15-18 for more about using Early Token Release with the Bridge Program.

Bridge Program (Version 2.0) Configuration Parameters

Parameters that define functions of the bridge are set in a configuration file that you create before the Bridge Program is loaded. A configuration file provided on the diskette with the Bridge Program contains default parameters. A Configuration Program, supplied on the diskette with the Bridge Program, helps you alter the default values to meet the needs of your network.

The person preparing each Bridge Program working disk or diskette for your network will ask you or the network planner to provide a completed copy of the Bridge Planning Chart (see the *IBM Token-Ring Network Bridge Program User's Guide*), indicating any changes to the bridge configuration parameters.

Once set, all configuration parameters can be permanently changed by using the Configuration Program to alter the file again and restarting the Bridge Program. Some parameters can be changed by the IBM LAN Manager. "Using Bridging Products with the IBM LAN Manager and the IBM LAN Network Manager" on page 15-20 indicates which parameters can be changed by each version of the IBM LAN Manager.

The bridge configuration parameters are:

- Bridge number

  This parameter uniquely identifies a bridge to the Bridge Program when frames are forwarded through the bridge. The network administrator or planner assigns a bridge number to each bridge in the network. Multiple bridges spanning the same two LAN segments (that is, parallel bridges) **must** have different bridge numbers.

- LAN segment numbers

  These two parameters specify the 3-digit number used to identify to the adapter the LAN segment to which each bridge adapter is connected. The value for the LAN segment to which the primary adapter is connected must be different from the value for the LAN segment to which the alternate adapter is connected.

  Note: All bridges connected to a specific LAN segment must refer to that LAN segment by the same number.

- Frame forwarding active

  This parameter indicates whether the Bridge Program is to begin passing frames through the bridge as soon as initialization is complete, or is to wait until a network manager program establishes a link with the bridge and turns on frame forwarding. (The IBM LAN Manager, Version 2.0, can turn bridge frame forwarding on and off; Version 1.0 does **not** contain function to turn bridge frame forwarding on and off.)

- Bridge performance threshold

  This parameter specifies the maximum allowable number of frames that are not forwarded through the bridge, per 10,000 frames arriving at the bridge, due to adapter congestion, a beaconing target ring, or invalid frames. Each time the threshold is exceeded, the Bridge Program counts a "threshold exceeded occurrence" and sends a notification to any linked network manager programs.

  You may need to adjust the bridge performance threshold value over time to provide a better correlation between the occurrence of the threshold being exceeded and user perception of a problem in response time, data exchange, or application program operation. See "Bridge Performance Analysis" on page 13-6 for more information about determining the value to use for the Bridge performance threshold.

- Restart on error

  This function causes the bridge computer to restart automatically, reload DOS, and reload the Bridge Program if an adapter check or a critical resource depletion occurs. If this function is used, all of the commands necessary to load the Bridge Program must be contained in an AUTOEXEC.BAT batch load file on the default drive. None of the commands must require operator intervention before the load continues (such as time or date requests).

  Automatic loading can be particularly useful if the device in which it runs is used only for the bridge (there would not be conflicting AUTOEXEC.BAT files on the default drive, or a need for operator intervention at load time).

  Note: If you use both the Restart on error and Memory dump on error functions, the AUTOEXEC.BAT file must be located on the same drive specified for the Memory dump on error.

- Drive for memory dump on error

  If a Bridge Program internal program error occurs, the Bridge Program writes a file containing an image (dump) of itself and its buffers from computer memory onto the fixed disk or diskette drive specified by this parameter. There must be sufficient space on the specified disk or diskette for the dump file.

  You will need to give instructions to the bridge operator for preserving the dump file and attempting to restart the Bridge Program:

  - You may need to give a copy of the dump file and a copy of your Bridge Program working disk or diskette to your service supplier if you cannot resolve the problem.
  - If the dump file is on the fixed disk or the Bridge Program working diskette, copy the file to a separate diskette before trying to restart the Bridge Program.
  - The last records in the ECCLOG.DAT file should indicate the reason for the termination of the Bridge Program.

- Drive for error log

  This parameter specifies the fixed disk or diskette drive to be used to log the messages generated when the Bridge Program terminates operation either by operator request or because of an adapter check or critical resource depletion.

  The error log file (ECCLOG.DAT) must be erased and the Bridge Program restarted to clear the file when it fills up. A text editor must be used to display the contents of the file.

The file entries can provide problem determination information, particularly in cases where the bridge is unattended for long periods of time and uses **Restart on error** to reload the bridge program after an error causes it to terminate.

- Hop count limit

  This parameter specifies the number of consecutive bridges through which a broadcast frame may travel, including the current bridge. This parameter does not apply to non-broadcast frames or to single-route broadcast frames.

  If the number of bridges the frame has passed through is equal to or greater than this hop count limit value, the frame will not be transmitted further.

- Single-route broadcast

  This parameter specifies whether single-route broadcast frames are to be passed from one LAN segment to the other through the bridge computer. The IBM Token-Ring Network Bridge Program Version 2.0 allows you to choose either manual mode or automatic mode.

  - For manual mode, you must manually determine which bridges in your network should have single-route broadcast active, and set the single-route broadcast parameters to active or inactive for each individual bridge during bridge configuration.
  - For automatic mode, the bridge programs in your network automatically set and modify the single-route broadcast parameters for each bridge to compensate for changes in network configuration.

    For each bridge that uses automatic mode, you can specify or use default values for:

    - A bridge label (a 2-byte identifier)
    - A path cost increment.

  See "Single-Route Broadcast" on page 15-6 for more information about using the single-route broadcast bridge function.

- Parameter server

  This parameter specifies for each LAN segment whether or not the Parameter server functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Parameter server provides the LAN segment number to an adapter when the adapter is attaching to the LAN segment, and sends a notification to one or more network manager programs when a new adapter has attached to the LAN segment.

  Note: If the Bridge Program reports to the IBM LAN Manager Version 2.0 or the IBM LAN Network Manager, you must enable the Parameter server during bridge configuration. Otherwise, the communication link between the IBM LAN Manager or the LAN Network Manager and the bridge cannot be established.

- Error monitor

  This parameter specifies for each LAN segment whether or not the error monitor functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Error monitor does the following:

  – Compiles error statistics reported by adapters on either LAN segment

  – Analyzes the statistics to determine a probable cause of errors degrading network operation

  – Sends reports to indicate critical problems to the IBM LAN Manager programs that have requested reports

  – Updates the **LAN Segment Status** area of the Bridge Program panels to "Soft Error" when appropriate

  If the error monitor parameter value is **N (No)**, the Bridge Program will not display error information for that LAN segment. The error information on the Network Status Details panel will be zeros, and the LAN segment status "Soft Error" will not be displayed on the Bridge Program panels when soft errors occur.

- Configuration report server

  This parameter specifies for each LAN segment whether or not the configuration report server functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The configuration report server sends notifications about the current active configuration of each LAN segment to the IBM LAN Manager programs that request reports. It reports changes in NAUN addresses and active monitor on the LAN segment.

- Link passwords

  The Bridge Program uses these passwords to determine that an IBM LAN Manager or LAN Network Manager program is authorized to establish a communication link with the Bridge Program. The IBM LAN Manager and the IBM LAN Network Manager request and receive network management reports and notifications from the Bridge Program over the link. The controlling IBM LAN Manager or LAN Network Manager program (the program that established link 0) can change some Bridge Program configuration parameters in the bridge computer memory. Bridge configuration parameter values changed by the IBM LAN Manager or LAN Network Manager are recorded in the ECCPARMS.BIN file.

  The IBM LAN Manager or LAN Network Manager program must give a valid password when it is establishing a link or the link request will be rejected. Note that if the link password is not changed from the default (which is "00000000") during Bridge Program configuration, the IBM LAN Manager or LAN Network Manager link must still specify that the password is "00000000".

  Up to four IBM LAN Manager or LAN Network Manager programs can concurrently establish a communication link with the Bridge Program. Each IBM LAN Manager or LAN Network Manager program must use a different one of the four link passwords.

  The completed Bridge Planning chart should show any link passwords used instead of the defaults. Give a copy of the passwords to the person doing configuration for the IBM LAN Manager or LAN Network Manager programs that will communicate with your bridge. Keep the Bridge Planning Chart in a secure place for future reference.

Bridge Program (Version 2.0) Output

The Bridge Program displays status and error information about:

- Each ring connected to the bridge
- The adapters in the bridge computer
- The functioning of the Bridge Program itself
- Any links to network manager programs.

Panels contain the displayed information, and allow selection of Bridge Program functions.

The status of each of the two rings (LAN segments) that are connected by the bridge is shown on the bottom line of the screen. The line above the LAN segment status line indicates which function keys are currently active. The line above the function key indicators is used to display any messages that occur while the panel is being displayed. The center of the panel contains possible function selections, a display of information requested by the operator, or information to help you use the bridge functions.

LAN Segment Status
The status of each of the two LAN segments is shown on the bottom line of the screen, one on the left and one on the right:

Normal: The LAN segment is operating normally.

Adapter Closed: This IBM Token-Ring Network adapter used by the bridge is no longer logically attached to the LAN segment.

Soft Error: The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly.

Wire Fault: There is a problem between the bridge computer's network adapter and the access unit to which it is connected. The network adapter, the cable from the network adapter to the access unit, or the access unit could be the source of the problem. This network adapter in the bridge computer is closed.

Beaconing: The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating the network within a predefined time limit.

LAN segment status details can be requested and displayed on a panel. These details show the most recent soft error and beaconing condition for each ring. And they show the portion of the ring most likely to contain the error (the *fault domain*).

Bridge Program Status
The messages near the bottom of the screen and the information that can be displayed in the center of the panel include details about:

- The functioning of the Bridge Program and the bridge adapters
- The configuration parameter settings currently being used by the Bridge Program (asterisks indicate which ones have been modified by the IBM LAN Manager or the IBM LAN Network Manager)
- The traffic flowing through the bridge (performance)
- Links with network manager programs.

The bridge traffic information that can be displayed includes:

- The Path Trace Log

  Any frame passed across the bridge that has the system path trace request bit set on will cause an entry to be logged in the Path Trace Log. Entries can be displayed and cleared using the Bridge Program Path Trace panel.

- The performance counters and statistics.

  The performance counters and statistics provide information about frames that are forwarded and not forwarded through the bridge.

  See "Bridge Performance Analysis" on page 13-6 for a description of the meaning and use of the Bridge Program performance information.

The IBM Token-Ring Network Bridge Program (Version 2.1)

The IBM Token-Ring Network Bridge Program Version 2.1 joins together two rings of an IBM Token-Ring Network, permitting communication between devices connected to different rings.

For local bridging, the IBM Token-Ring Network Bridge Program Version 2.1 requires a dedicated workstation (referred to in this discussion as the bridge computer), with two IBM Token-Ring Network adapters installed. The bridge computer is an attaching device on a lobe of each ring. The adapter cable for each bridge adapter must be able to reach an access unit connected to the appropriate ring. Therefore, the two access units must be located near each other and near the bridge device.

The Bridge Program uses source routing to transfer data between two rings of an IBM Token-Ring Network. Devices that support source routing can communicate through the bridge, even though they are attached to different rings.

As well as providing the means to transfer data between two rings, the Bridge Program provides:

- Ring status and error information (similar to that supplied by the Ring Diagnostic and the IBM LAN Manager) that can be used for problem determination.
- Bridge performance information that can help you evaluate and manage traffic flow through the bridge.
- Function to allow up to four network manager programs (such as the IBM LAN Manager) to establish links with the Bridge Program, over which the Bride Program can send ring status, adapter status, error information, and bridge performance information to the network manager programs.
- A self-test to see that the bridge is able to send and receive data on and across both rings.
- Support for two IBM Token-Ring Network adapters that are compatible with your bridge computer. These do not have to be the same type of adapter.
- Support for bridging two rings that are running at different data transfer rates. For example, a 4-Mbps ring and a 16-Mbps ring can be bridged.
- A spanning-tree protocol for automatic configuration of the single-route broadcast path.

In addition to the above functions, Version 2.1 of the Bridge Program provides:

- Remote bridging of two rings where the adapter cables of a single bridge computer cannot reach the access units of the rings. Remote bridging requires two bridge computers, each with an IBM Token-Ring Network adapter and a communications adapter. The two bridge computers are connected through external modems and a leased serial telecommunications line.
- Frame filtering to improve network performance and security.

Note: The bridges do not support the IBM Token-Ring Network 16/4 Busmaster Server Adapter/A.

During Bridge Program installation, you will need to specify values or use the default values for:

- Bridge program installation parameters
- Bridge Program configuration parameters
- Communication adapter configuration parameters (remote bridge function only).

Bridge Program (Version 2.1) Installation Parameters

The bridge installation parameters include some adapter configuration parameters usually specified in the IBM LAN Support Program configuration. However, the Bridge Program contains its own adapter support code and does not require the Support Program.

The Bridge Program *User's Guide* contains separate descriptions of the following parameters for the local and remote bridge functions. Their use with each function differs slightly. The following parameters must be specified during Bridge Program installation:

- Adapter name

  This parameter specifies the type of primary and alternate adapter installed in the bridge computer (for example, Adapter II, Adapter/A, or 16/4 Adapter). (This parameter applies to the local bridge function; the bridge adapter for each bridge half in a bridge using the remote bridge function is the primary adapter.)

- Adapter data rate

  This parameter specifies whether each ring operates at 4 or 16 Mbps.

- Locally administered address

  This parameter allows you to assign a locally administered address to each bridge adapter, to override the universally administered address. Each locally administered address must be unique on the network. See "IBM LAN Network Addressing" on page 1-25 for more about assigning locally administered addresses.

- Shared RAM address

  This parameter defines for each adapter the location in computer memory to be used for the RAM shared by the computer and the adapter. A different address must be used for each adapter that is installed in the same bridge computer. The defaults are recommended unless there is a specific and critical need to use other addresses.

  Each shared RAM address must be located on a 16-KB boundary and is dependent upon the options installed in your computer. Each adapter's shared RAM address must not conflict with any of the following addresses:

  - Shared RAM address of the other network adapter in the same bridge station
  - ROM address of this bridge adapter
  - ROM address of the other network adapter in the same bridge station
  - The shared storage window address of the IBM X.25 Interface Co-Processor/2 Adapter or IBM Realtime Interface Co-Processor (for the remote bridge function only).

If you have a specific need to use values other than the defaults, refer to the *IBM Token-Ring Network Bridge Program User's Guide* and:

- For IBM Token-Ring Network adapters used in bridge computers with PC/IO Channel architecture (such as the IBM Token-Ring Network PC Adapter II and the IBM Token-Ring Network 16/4 Adapter), use the memory map in the adapter's *Guide to Operations* to select a value for this parameter.
- For IBM Token-Ring Network adapters used in bridge computers with Micro Channel architecture (such as the IBM Token-Ring Network Adapter/A and the IBM Token-Ring Network 16/4 Adapter/A), use the configuration information on the computer's Reference Diskette to determine and set the shared RAM address for each adapter.
- For the IBM Realtime Co-Processors, refer to *IBM Realtime Co-Processor Guide to Operations* to select a value for the shared storage window address.
- For the IBM X.25 Interface Co-Processor/2 Adapter, use the configuration information on the reference diskette to set the shared storage window address.

- Early Token Release

  Early Token Release is valid only for IBM Token-Ring Network adapters that support network data rates of both 4 and 16 Mbps as adapter configuration parameters. This option increases the utilization of the network by reducing the average time required for a network adapter to gain access to a token. It is automatically enabled when a 16/4 adapter's data rate is set to 16 Mbps. Early Token Release is ignored if the IBM Token-Ring Network segment operates at a data rate of 4 Mbps. See "Using Early Token Release with Bridges" on page 15-18 for more about using Early Token Release.

Bridge Program (Version 2.1) Configuration Parameters

Parameters that define functions of the bridge are set in a configuration file that you create before the Bridge Program is loaded. A configuration file provided on the diskette with the Bridge Program contains default parameters. A Configuration Program, supplied on the diskette with the Bridge Program, helps you alter the default values to meet the needs of your network.

The person preparing each Bridge Program working disk or diskette for your network will ask you or the network planner to provide a completed copy of the Bridge Planning Chart (see the *IBM Token-Ring Network Bridge Program User's Guide*), indicating any changes to the bridge configuration parameters.

Once set, all configuration parameters can be permanently changed by using the Configuration Program to alter the file again and restarting the Bridge Program. Some parameters can be changed by the IBM LAN Manager or LAN Network Manager "Using Bridging Products with the IBM LAN Manager and the IBM LAN Network Manager" on page 15-20 indicates which parameters can be changed by each version of the IBM LAN Manager or LAN Network Manager.

The bridge configuration parameters are:

- Bridge number

  This parameter uniquely identifies a bridge to the Bridge Program when frames are forwarded through the bridge. The network administrator or planner assigns a bridge number to each bridge in the network. Multiple bridges spanning the same two LAN segments (that is, parallel bridges) **must** have different bridge numbers.

- LAN segment numbers

  These two parameters specify the 3-digit number used to identify to the adapter the LAN segment to which each bridge adapter is attached. For bridges using the local bridge function, the value for the LAN segment to which the primary adapter is attached must be different from the value for the LAN segment to which the alternate adapter is attached. For bridges using the remote bridge function, the value for the LAN segment to which the primary bridge half is attached must be different from the value for the LAN segment to which the secondary bridge half is attached.

  Note: All bridges connected to a specific LAN segment must refer to that LAN segment by the same number.

- Frame forwarding active

  This parameter indicates whether the Bridge Program is to begin passing frames through the bridge as soon as initialization is complete, or is to wait until a network manager program establishes a link with the bridge and turns on frame forwarding. (The IBM LAN Manager Version 2.0 and the IBM LAN Network Manager can turn bridge frame forwarding on and off; Version 1.0 does **not** contain functions to turn bridge frame forwarding on and off.)

- Maximum frame size

  This parameter is for the remote bridge function only.

  For local bridge function, the maximum frame size is automatically calculated based on the capabilities of the installed adapter.

  This parameter specifies the largest frame (in bytes) that a bridge using the remote bridge function can process. The Bridge Program discards frames larger than the specified maximum frame size.

  When you specify the default value of 0 for the maximum frame size parameter, the Bridge Program selects the default maximum frame size from the values shown in Table 15-4. The Bridge Program selects the default value shown for the line data rate of the telecommunications link connecting the two bridge computers.

Table 15-4. Maximum Frame Size Default Values Used by Bridge Program

Line Data Rate	**Recommended Maximum Frame Size**
9.6 Kbps $\leq$ D $<$ 38.4 Kbps	516 bytes
38.4 Kbps $\leq$ D $<$ 56 Kbps	1500 bytes
56 Kbps $\leq$ D $\leq$ 1.344 Mbps	2052 bytes

Note: D = Line Data Rate

If the maximum frame size sent to the bridge by an application program or device is smaller than the value shown in the table for a given line data rate, you can change the maximum frame size parameter value as follows:

Parameter Value	Maximum Frame Size
1	516 bytes
2	1500 bytes
3	2052 bytes

If a device or application program does not support a maximum frame size as small as the one shown for the given line data rate, you can:

- Try specifying the parameter value for the maximum frame size supported by the device or program (you should *not* do this for 9.6 Kbps links; consider using a higher line data rate instead).
- Consider using a telecommunications link with a higher line data rate for the bridge used by those devices or applications.

There are a number of factors, including maximum frame size, that you must consider in the configuration and use of a bridge that uses the remote bridge function. See "Considerations for Using the Remote Bridge Function" on page 13-40 for information about the parameters and variables to consider.

- Bridge performance threshold

  This parameter specifies the maximum allowable number of frames that are not forwarded through the bridge, per 10,000 frames arriving at the bridge, due to adapter congestion, a beaconing target ring, or invalid frames. Each time the threshold is exceeded, the Bridge Program counts a "threshold exceeded" occurrence in the Performance Statistics and sends a notification to any linked network manager programs.

  Note: The total number of frames arriving at the bridge and the total number of frames in error (excluding telecommunications link errors) are used for the remote bridge function to determine if the threshold has been exceeded. The total number of frames arriving at the bridge includes a count of frames filtered. The total number of frames in error (excluding telecommunications link errors) does not include this count. The count of frames filtered is not included in notifications to any network manager program.

  You may need to adjust the bridge performance threshold value over time to provide a better correlation between the occurrence of the threshold being exceeded and user perception of a problem in response time, data exchange, or application program operation.

  See "Bridge Performance Thresholds" on page 13-16 for more information about changing the bridge performance threshold value.

- Telecommunications link error threshold

  This parameter specifies the maximum allowable number of frames not received across a bridge, per 10,000 frames arriving at the bridge, due to errors on the telecommunications link connecting the two stations of a bridge using the remote bridge function. It expresses the number of frames forwarded onto the telecommunications link from one side of the bridge and not received by the other side of the bridge, before the Bridge Program counts a "threshold exceeded" occurrence in the Performance Statistics. The Bridge Program also sends a notification to any network manager programs that have requested such reports.

Note: The count of frames filtered is not included in the calculation to determine if the threshold has been exceeded. Filtered frames are not forwarded onto the telecommunications link, and cannot be lost due to telecommunications link errors.

The default telecommunications link error threshold values shown in Table 15-5 on page 15-45 were determined from calculations based on the following:

- Line data rate of the telecommunications link between the two bridge stations
- A line quality of 67% error-free seconds along with the corresponding approximate bit error rate
- Maximum average frame size that crosses the telecommunications link

  This value is the higher of the two frame size averages, one in each of the two directions across the bridge.

If you know only the line data rate, and not the maximum average frame size crossing the bridge in both directions, do the following:

1. Initialize the bridge the first time using the default telecommunications link error threshold value shown in Table 15-5 on page 15-45 for the line data rate used by the bridge.
2. Run the bridge for approximately 24 hours to observe bridge operation and record the bridge performance counter values (bytes and frames forwarded counters) at intervals of at least 15 minutes.

   If your observation of bridge and network operation does not indicate that the threshold value is too high or too low, continue bridge operation with the default value.

   If, however, the operation of the bridge and the network indicate that the threshold value should be altered from the default, see "Bridge Performance Thresholds" on page 13-16 for instructions on how to determine the new value. You will need the bytes forwarded and frames forwarded counter values to determine the average frame sizes.

   - A threshold value set too low may cause an indication too often that the threshold was exceeded. The number of link errors occurring may not be sufficient to be causing lost user communication or other problems noticeable by the network users.
   - A value set too high may not warn you soon or often enough that link errors are causing lost sessions or other problems noticeable by network users.

Once the bridge is installed and operating, a "threshold exceeded" occurrence for this threshold indicates one or more of the following conditions:

- The quality of the bridge telecommunications link may have degenerated below the given approximate bit error rate.
- The communication equipment used with the bridge is malfunctioning.

- The network has changed, altering the kind and/or amount of traffic crossing the bridge. The maximum average frame size may have changed enough to require a change in the threshold parameter value.

If you determine that you should change the threshold value from the default value, see the instructions in "Bridge Performance Thresholds" on page 13-16 for:

- How to use the counter values to determine the maximum average frame size for the bridge
- How to calculate a more accurate threshold value for this bridge, on the basis of the maximum average frame size and the line data rate.

Table 15-5. Default Values for the Telecommunications Link Error Threshold

If you have the following line data rate	Then use the following default threshold value (frames/10,000)	Assumed maximum average frame size in bytes	Approximate bit error rate
9.6 Kbps	**1581**	516	4.17 X 10^{-5}
19.2 Kbps	**815**	516	2.06 X 10^{-5}
38.4 Kbps	**1173**	1500	1.04 X 10^{-5}
56 Kbps	**1085**	2052	7 X 10^{-6}
64 Kbps	**972**	2052	6.23 X 10^{-6}
256 Kbps	**253**	2052	1.56 X 10^{-6}
512 Kbps	**127**	2052	7.83 X 10^{-7}
1.344 Mbps	**49**	2052	2.98 X 10^{-7}

The approximate bit error rates in this table are based on a % error-free-seconds value of 67%.

The formula used by the Bridge Program to calculate the telecommunications link error threshold assumes the values provided in this table for the maximum average frame size and the "worst case" approximate bit error rate.

- Restart on error

  This function causes the bridge computer to restart automatically, reload DOS, and reload the Bridge Program if an adapter check or a critical resource depletion occurs. If this function is used, all of the commands necessary to load the Bridge Program must be contained in an AUTOEXEC.BAT batch load file on the default drive. None of the commands must require operator intervention before the load continues (such as time or date requests).

  Automatic loading can be particularly useful if the device in which it runs is used only for the bridge (there would not be conflicting AUTOEXEC.BAT files on the default drive, or a need for operator intervention at load time).

  Notes:

  1. If you use both the Restart on error and the Memory dump on error functions, the AUTOEXEC.BAT file must be located on the same drive specified for the Memory dump on error.
  2. Restart on error can be used with the remote bridge function, as long as the cause of the restart is a Bridge Program problem. If the telecommunications link or connecting communication equipment are malfunctioning, manual intervention will be required to restart the bridge.

- Drive for memory dump on error

  If a Bridge Program internal program error occurs, the Bridge Program writes a file containing an image (dump) of itself and its buffers from computer memory onto the fixed disk or diskette drive specified by this parameter. There must be sufficient space on the specified disk or diskette for the dump file.

  You will need to give instructions to the bridge operator for preserving the dump file and attempting to restart the Bridge Program:

  - You may need to give a copy of the dump file and a copy of your Bridge Program working disk or diskette to your service supplier if you cannot resolve the problem.
  - If the dump file is on the fixed disk or the Bridge Program working diskette, copy the file to a separate diskette before trying to restart the Bridge Program.
  - The last records in the ECCLOG.DAT file usually indicate the reason for the termination of the Bridge Program.

- Drive for error log

  This parameter specifies the fixed disk or diskette drive to be used to log in the ECCLOG.DAT file the messages generated when the Bridge Program terminates operation either by operator request or because of an adapter check or critical resource depletion.

  The error log file (ECCLOG.DAT) must be erased and the Bridge Program restarted to clear the file when it fills up. A text editor must be used to display the contents of the file.

  The file entries can provide problem determination information, particularly in cases where the bridge is unattended for long periods of time and uses **Restart on error** to reload the bridge program after an error causes it to terminate.

- Hop count limit

  This parameter specifies the number of consecutive bridges through which a broadcast frame may travel, including the current bridge.

  For the IBM Token-Ring Network Bridge Program Version 2.1, hop count applies only to broadcast frames (not to non-broadcast frames or to single-route broadcast frames).

  If the number of bridges the frame has passed through is equal to or greater than this hop count limit value, the frame will not be transmitted further.

- Parameter Server

  This parameter specifies for each LAN segment whether or not the Parameter Server functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Parameter Server provides the LAN segment number to an adapter when the adapter is attaching to the LAN segment, and sends a notification to one or more network manager programs when a new adapter has attached to the LAN segment.

  Note: If the bridge program reports to the IBM LAN Manager Version 2.0, you must enable the Parameter Server during bridge configuration. Otherwise, the communication link between the IBM LAN Manager and the bridge cannot be established.

- Error Monitor

  This parameter specifies for each LAN segment whether or not the Error Monitor functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Error Monitor does the following:

  - Compiles error statistics reported by adapters on either LAN segment
  - Analyzes the statistics to determine a probable cause of errors degrading network operation
  - Sends reports to indicate critical problems to the IBM LAN Manager programs that have requested reports
  - Updates the **LAN Segment Status** area of the Bridge Program panels to "Soft Error" when appropriate

  If the Error Monitor parameter value is **N (No)**, the Bridge Program will not display error information for that LAN segment. The error information on the Network Status Details panel will be zeros, and the LAN segment status "Soft Error" will not be displayed on the Bridge Program panels when soft errors occur.

- Configuration Report Server

  This parameter specifies for each LAN segment whether or not the Configuration Report Server functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

The Configuration Report Server sends notifications about the current active configuration of each LAN segment to the IBM LAN Manager programs that request reports. It reports changes in NAUN addresses and active monitor on the LAN segment.

- Single-Route Broadcast

  This parameter specifies whether single-route broadcast frames are to be passed from one LAN segment to the other through the bridge computer. The IBM Token-Ring Network Bridge Program Version 2.1 allows you to choose either manual mode or automatic mode.

  - For manual mode, you must manually determine which bridges in your network should have single-route broadcast active, and set the single-route broadcast parameters to active or inactive for each individual bridge during bridge configuration.
  - For automatic mode, the bridge programs in your network automatically set and modify the single-route broadcast parameters for each bridge to compensate for changes in network configuration.

    For each bridge that uses automatic mode, you can specify or use default values for:

    - A bridge label (a 2-byte identifier)
    - A path cost increment.

  See "Single-Route Broadcast" on page 15-6 for more information about using the single-route broadcast bridge function.

  Warning: The IBM Token-Ring Network Bridge Program Version 2.2, using the automatic mode of the single-route broadcast parameter, will not recognize the existence of the IBM Token-Ring Network Bridge Program Versions 1.0, 1.1, and 2.0 without PTF UR25531, or the IBM PC Network Bridge Program without PTF UR25532. This may cause the following problems:

  - Some LAN segments may become isolated from the network.
  - Some LAN segments may receive duplicate single-route broadcast frames.

  If you have the IBM Token-Ring Network Bridge Program Version 2.2 and you have either of the bridge programs listed below in your network, and you want to use the automatic mode of the single-route broadcast parameters you must use the following PTFs.

Table 15-6. PTF Numbers Required for Automatic Mode

Name of Bridge Program	**PTF Number**
IBM Token-Ring Network Bridge Program Version 2.0	PTF UR25531 or later
IBM PC Network Bridge Program Version 1.0	PTF UR25532 or later

Refer to the "Statement of Service" in the *IBM Token-Ring Network Bridge Program User's Guide Version 2.2* for information about obtaining PTF numbers and other access to program services from your IBM representative. If you do not use the PTF with these bridges, you will **not** be able to use the automatic mode of the single-route broadcast parameter of these bridges with Version 2.2 in the same network.

See "Single-Route Broadcast" on page 15-6 for more information about using the single-route broadcast bridge function.

- Link passwords

  The Bridge Program uses these passwords to determine that an IBM LAN Manager or LAN Network Manager program is authorized to establish a communication link with the Bridge Program. The IBM LAN Manager and LAN Network Manager request and receive network management reports and notifications from the Bridge Program over the link. The controlling IBM LAN Manager or LAN Network Manager program (the program that established link 0) can change some Bridge Program configuration parameters in the bridge computer memory. Bridge configuration parameter values changed by the IBM LAN Manager or LAN Network Manager are recorded in the ECCPARMS.BIN file.

  The IBM LAN Manager or LAN Network Manager program must give a valid password when it is establishing a link or the link request will be rejected. Note that if the bridge link password is not changed from the default (which is "00000000"), the IBM LAN Manager or LAN Network Manager link must use the password "00000000."

  Up to four IBM LAN Manager or LAN Network Manager programs can concurrently establish a communication link with the Bridge Program. There can be one primary and up to three observing LAN Managers or LAN Network Managers for each LAN segment. Primary and observing LAN Managers or LAN Network Managers use different passwords. For more information on link passwords, see the *IBM LAN Network Manager User's Guide*. Each IBM LAN Manager or LAN Network Manager program must use a different one of the four link passwords.

  The completed Bridge Planning chart should show any link passwords used instead of the defaults. Give a copy of the passwords to the person doing configuration for the IBM LAN Manager or LAN Network Manager programs that will communicate with your bridge. Keep the Bridge Planning Chart in a secure place for future reference.

Remote Bridge Communications Adapter Configuration Parameters

The IBM Token-Ring Network Bridge Program Version 2.1 supports the remote bridge function. A communications adapter connects each station of a bridge using the remote bridge function to one end of a telecommunications link. Each bridge station forwards frames from one LAN segment to the other over the telecommunications link.

The bridge requires one communications adapter configuration file (ECCSBPRM.BIN) for **each half** of the bridge (primary and secondary bridge halves). You can use the Communications Adapter Configuration Program to specify communication adapter configuration parameter values for:

- Line data rate

  The line data rate is the speed at which the telecommunications link is to be clocked externally by a DCE (such as a modem) for data transfer. Telecommunications link data rates range from 9.6 Kbps to 1.344 Mbps.

- Electrical interface

  The electrical interface indicates what type of electrical interface is being used at the communications adapter DCE (RS-232, V.35, or X.21).

- Communications adapter transmit buffer size

  The communications adapter transmit buffer size is the maximum number of bytes that can be in the communications adapter transmit queue at one time. For a default value of 0, the Bridge Program uses the value shown in Table 15-7 for the line data rate used by the link.

Table 15-7. Communications Adapter Transmit Buffer Size Default Values for Commonly Used Line Data Rates

Line Data Rate	Value
9.6 Kbps	1,100
19.2 Kbps	2,200
56 Kbps	6,417
64 Kbps	7,489
512 Kbps	56,320
1.344 Mbps	65,536

The Bridge Program communication adapter transmit buffer sizes were determined by using the formulas shown in Table 15-8 on page 15-51, with an IEEE 802.2 LLC T1 timer value of 1.1 seconds. The default values shown in the table are intended to maximize the utilization of the bridge when using the remote bridge function. The formula used depends upon the line data rate of the telecommunications link between the two bridge computers.

The IEEE 802.2 LLC T1 timer value is a parameter specified in device configuration or in program configuration or generation for the programs and devices that send frames across the bridge. The IEEE 802.2 LLC T1 timer value that should be used to calculate a value for the bridge communications adapter transmit buffer size is the smallest IEEE 802.2 LLC T1 timer value (specified or default) used by any station on the two LAN segments connected by the bridge. Use the same IEEE 802.2 LLC T1 timer value for both halves of the bridge.

You may need to change the communications adapter transmit buffer size if one or more of the following are true:

- The line data rate used by the bridge telecommunications link is different from any of those in Table 15-7 on page 15-50
- The smallest IEEE 802.2 LLC T1 timer value used on the two LAN segments is not 1.1 seconds.

If you want to change the buffer size, use the appropriate formula from Table 15-8 to determine the correct buffer size to use. Change the buffer size in the communications adapter configuration and restart the bridge.

Table 15-8. Communications Adapter Transmit Buffer Size Formulas

Line Date Rate	Assumed Bit Error Rate	Formula or Value
9.6 Kbps $\leq$ D $<$ 64 Kbps	10^{-5} or better	$N = \frac{D \times T1}{9.6}$
64 Kbps $\leq$ D $<$ 512 Kbps	10^{-5} or 10^{-6}	$N = \frac{D \times T1}{9.4}$
512 Kbps $\leq$ D $<$ 530 Kbps	10^{-6} or better	$N = \frac{D \times T1}{8.9}$
D $\geq$ 530 Kbps	10^{-6} or better	N = 65,536

Note:

N = Buffer limit in KB (**Note**: Here, K = 1000.)
D = Line data rate in Kbps
T1 = Timer value in seconds
(calculations for defaults use 1.1 seconds).

Filter Programs

You can use filter programs with the IBM Token-Ring Network Bridge Program Version 2.1 to limit the traffic that can cross a bridge.

You may want to limit bridge traffic for the following reasons:

- Network performance

  This can be an important consideration for bridges using remote bridge telecommunications links with line data rates (such as 9.6 Kbps) that are much lower than LAN and local bridge data transmission rates. The application programs on a LAN segment may be able to send data to a bridge that uses the remote bridge function faster than the bridge can process frames and transfer them over the link to the other LAN segment. You may want to limit the number of pairs of users that can exchange information at one time across a bridge that uses the remote bridge function.

- Network security

  You can use a filter program to permit only certain adapter addresses to send files across a bridge (to a particular file server or print server, for example).

Filter programs can limit the traffic that can cross a bridge in a number of ways, including:

- Restricting the number of pairs of users exchanging information across the bridge at one time
- Forwarding or filtering frames from specific adapter addresses
- Forwarding or filtering frames with certain values in specific fields.

Use of filter programs with the Bridge Program is optional. You may choose to use filter programs to limit the traffic crossing some or all bridges in the network that use the IBM Token-Ring Network Bridge Program Version 2.1. You need to consider:

- What traffic needs to cross each bridge that uses the IBM Token-Ring Network Bridge Program Version 2.1 in your network
- Whether you need to use one or more filter programs to limit the traffic crossing one or more bridges.

You can use up to 10 filter programs with:

- Each half of a bridge using the remote bridge function (primary and secondary half)
- Each adapter of a bridge using the local bridge function (primary and alternate adapter).

Each bridge half or adapter does not have to use the same filter programs. Filtering is done only for frames sent to the bridge on the source LAN segment, to determine whether to forward the frames across the bridge to the destination LAN segment. Frames that have been forwarded across the bridge are not filtered as they arrive at the side of the bridge connected to the destination LAN segment.

IBM-Supplied Filter Programs

The *IBM Token-Ring Network Bridge Program User's Guide* for Version 2.1 describes the function, installation, and use of the three filter programs supplied on the Bridge Program diskette. Here is a brief description of those programs:

- The **link limiting filter program**, FILTER1.COM, which limits the number of pairs of adapter addresses that can exchange information at one time through a bridge using the remote bridge function. This filter program can be used **only** with the remote bridge function.

  The link limiting filter program can help limit the traffic crossing the telecommunications link connecting the two bridge halves by limiting the number of pairs of unique source and destination addresses that can exchange information at one time through the bridge.

  If the bridge telecommunications link uses a low data rate, such as 9.6 Kbps, you may want to use this filter program. The line data rate of the telecommunications link (9.6 Kbps) is slower than that of the LAN segments connected by the bridge halves (4 or 16 Mbps). The application programs on a LAN segment may be able to send data to a bridge using the remote bridge function faster than the bridge can process frames and transfer them over the link to the other LAN segment.

- The **NETBIOS filter program**, FILTER2.COM, helps limit the proliferation of NETBIOS frames crossing a bridge from one LAN segment to the other. This filter program can be used with both the remote and the local bridge functions. This filter program makes a filtering decision based on NETBIOS names and frame types. The NETBIOS filter program maintains a table of NETBIOS names. You can specify:

  - A single name in the NAME load command parameter
  - A list of names in a file; you specify the name of the file in the FILE load command parameter.

  The filter program compares the names in the table with the source name field or the destination name field in the frame's NETBIOS header. A load command parameter indicates the action to be taken with frames for which there is a name match in the table.

- The **adapter address filter program**, FILTER3.COM, which filters (discards) all frames that contain source and destination addresses (a single pair of addresses, or a range of source addresses and a range of destination addresses) specified on the filter program load command. This filter program can be used with both the remote and the local bridge functions.

  You can use locally administered adapter addresses to make sure that the adapter addresses for which frames are to be filtered are within the specified range, and that adapter addresses that can send frames across the bridge are outside the specified range. You can do the following:

  1. Assign a locally administered address within the desired range to each adapter that is **not** allowed to send and receive frames across the bridge.
  2. Verify that the addresses used for adapters that **can** send frames across the bridge are outside the desired range. If any fall within the range, assign a locally administered address outside the range for those adapters.

Designing, Writing, and Using Your Own Filter Programs

If you want to use filter programs with the bridge, other than or in addition to the three filter programs supplied on the Bridge Program diskette, you must design and write your own.

The *IBM Token-Ring Network Bridge Program User's Guide* for Version 2.1 contains instructions for writing, assembling, and producing an executable module of a filter program.

Because the filter programs are called for every frame received at a bridge, each filter program should be as small as possible and execute as efficiently as possible. The performance of the bridge could become very dependent on the performance of the filter programs.

Designing Your Own Filter Programs

When designing your own filter Programs, you need to:

- Determine the need for the use of filter programs with the bridges that use the IBM Token-Ring Network Bridge Program Version 2.1 in your network.

  Consider particularly:

  - Bridges using the remote bridge function and telecommunications links with lower line data rates
  - NETBIOS traffic across bridges using the remote bridge function
  - Any security reasons for limiting access to services on a LAN segment (such as print or file servers).

  Consider the characteristics of the traffic that would cross each bridge (for example, frame types and size and frequency of file and message transfer), number and duration of active sessions between users across a bridge, and location of sending stations (filter programs need to be used with the bridge adapter or remote bridge half connected to the LAN segment containing the sending stations).

- Determine the criteria by which each filter program decides to either filter (discard) a frame or forward the frame across the bridge.

  The criteria can be a range of addresses, a number of pairs of source and destination addresses that can exchange information at one time, a value in some portion in the Information field, or a combination of criteria.

  For multiple filter programs, give consideration to whether one filter program should stop the filtering process when it decides to filter a frame (not letting subsequent filters see the frame). Consider also whether a filter program can have the capability to override a previous program's decision to filter a frame.

There are some differences between the filter programs that you write and the filter programs provided on the Bridge Program diskette. You need to consider those differences in designing your own filter programs and in using your filter programs with one or more of the supplied filter programs for the same local bridge adapter or remote bridge half.

- The three filter programs supplied on the Bridge Program diskette do **not** provide or recognize the pass-on flag. The frame will always be passed to the next filter program after one of the three filter programs has checked the frame.

- The three filter programs supplied on the Bridge Program diskette do **not** change the filter flag once it indicates a decision to filter a frame. The three filter programs check the filter flag upon receiving a frame. If the filter flag indicates to filter the frame, the three filter programs immediately return control to the adapter support code. The frame is then passed to the next, if any, filter program with the filter flag unchanged.

- The three filter programs allow the user to specify or omit the load parameter CONT.

  Omitting the parameter CONT causes Bridge Program initialization to pause if the filter program does not load and initialize successfully. A prompt is displayed which allows the user to see the error message and requests that the user press any key to continue executing the batch file commands. Once the batch file has resumed execution, the user may stop the batch file by pressing Ctrl-Break to return to the DOS prompt.

  Specifying the CONT parameter causes Bridge Program initialization to continue even if the filter program does not load and initialize successfully. You should use the CONT parameter for bridges that use the **Restart on error** function to automatically restart the bridge without operator intervention when an internal bridge error or critical resource depletion occurs.

Writing Your Own Filter Programs
Each filter program that you write has two major parts:

- Initialization

  In order to load when the Bridge Program loads, establish communication with the Bridge Program adapter support code, and remain resident in computer memory while the Bridge Program is running, the initialization portion of your filter program must include the following functions:

  1 Read and validate input data such as load parameters, if any.

  2 Issue a DIR.SET.FILTER.APPENDAGE CCB to the Bridge Program adapter support code. The CCB format is shown in the Bridge Program *User's Guide*.

  3 Check the return code upon return from the CCB command. Indicate to the bridge operator in some way any errors in the CCB format or any errors that occurred in loading the filter program.

  4 End initialization by terminating the filter program but having it stay resident.

- Frame filtering

  The frame filtering portion of each filter program should include the following functions:

  - Establish the criteria upon which to base the decision to forward or filter a frame.
  - Locate the fields in the frame to use in making the decision.
  - Compare the fields to the criteria, and make the decision.

- When the decision to forward or not forward the frame across the bridge has been made, set the result of the decision in the filter flag and set the pass-on flag to indicate whether the frame is to be passed to the next filter program (if any).
- Return control to the Bridge Program.

The adapter support code passes the filter flag just as it is from one filter program to the next one, and does not check the filter flag until after the last filter program has been called or until the pass-on flag indicates not to pass the frame to any other filter programs. If one filter program indicates that a frame should be filtered, a subsequent filter program can choose to:

- Check the filter flag upon entry, and return control to the Bridge Program immediately when the flag indicates that the frame is to be filtered.
- Continue checking criteria, and may override a previous filter program's decision to filter a frame.

Using Your Own Filter Programs

For each filter program that you design, you must:

- Write the program in a source language that is supported by DOS.
- Assemble the source module to obtain an object module.
- Link the object module to obtain an executable module of the program.
- Install the executable filter program module (and a parameter file, if required) on the Bridge Program working disk directory or diskette.
- Insert a load command with the name of the filter program and any load parameters into the FILTER.BAT file on the working disk or diskette.

The Bridge Program *User's Guide* contains specifications for writing your filter programs, instructions for preparing them for use, and installation instructions. The software installation steps described in the Bridge Program *User's Guide* help you to install the supplied and user-written filter programs on your Bridge Program working diskette or disk. The installation steps include:

- Putting the executable modules of the filter programs on the working disk or diskette in the sub-directory from which the Bridge Program is loaded.
- Inserting the file names of the filter programs with appropriate load parameters as load commands in the FILTER.BAT file in the working disk or diskette sub-directory from which the Bridge Program is loaded. (You decide whether the filter programs you write require or accept load parameters. The *User's Guide* describes the load command parameters for the three filter programs supplied on the Bridge Program diskette.)

  You insert the file names of the filter programs in the reverse of the order you want the Bridge Program to use them. The filter program whose name is listed last in the FILTER.BAT file receives control first.

The filter programs and the Bridge Program load at the same time. The filter programs run whenever the Bridge Program is running.

Once the filter programs are installed and loaded with the Bridge Program:

- Each time the bridge adapter receives a frame, the adapter support code included with the Bridge Program begins passing control to (calling) the filter programs. Each filter program called by the Bridge Program adapter support code decides whether the frame should be filtered (discarded). The adapter support code calls filter programs, in the reverse of the order in which they were loaded, until the last program is called or until a filter program indicates not to pass the frame on to the next filter program.
- The adapter support code does not check to see whether a frame should be filtered until there are no more filter programs that need to check the frame.
- The Bridge Program forwards or discards the frame according to the setting of the filter flag after the filter programs have completed the check of the frame. A subsequent filter program can override the decision of an earlier filter program on whether to forward or discard the frame.

If you decide to stop using a filter program, you must do the following:

1 Shut down the Bridge Program.

2 Delete the filter program load command from the FILTER.BAT file in the Bridge Program sub-directory.

3 Turn off the bridge computer power for at least 15 seconds. Then, turn the bridge computer power back on.

4 Restart the Bridge Program.

Bridge Program (Version 2.1) Output

The Bridge Program displays status and error information about:

- Each ring connected to the bridge
- The adapters in the bridge computer
- The functioning of the Bridge Program itself
- Any links to network manager programs.

Panels contain the displayed information, and allow selection of Bridge Program functions.

The status of each of the two rings (LAN segments) that are connected by the bridge is shown on the bottom line of the screen. The center of the bottom of the screen also shows the status of the telecommunications link connecting the two halves a bridge that uses the remote bridge function. The line above the LAN segment status line indicates which function keys are currently active. The line above the function key indicators is used to display any messages that occur while the panel is being displayed. The center of the panel contains possible function selections, a display of information requested by the operator, or information to help you use the bridge functions.

LAN Segment Status
The status of each of the two rings is shown on the bottom line of the screen, one on the left and one on the right:

Normal: The LAN segment is operating normally.

Adapter Closed: This IBM Token-Ring Network adapter used by the bridge is no longer logically attached to the LAN segment.

Soft Error: The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly.

Wire Fault: There is a problem between the bridge computer's network adapter and the access unit to which it is connected. The network adapter, the cable from the network adapter to the access unit, or the access unit could be the source of the problem. The network adapter in the bridge computer is closed.

Beaconing: The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating the network within a predefined time limit.

Network status details can be requested and displayed on a panel. These details show the most recent soft error and beaconing condition for each ring. And they show the portion of the ring most likely to contain the error (the *fault domain*).

Telecommunications Link Status
One of two telecommunications link status conditions may be displayed in the center of the bottom of the screen at each bridge half:

Normal: The telecommunications link is functioning normally.

Down: The telecommunications link cannot be used for bridge communication; either the link needs to be activated or a problem needs to be resolved.

Bridge Program Status
The messages near the bottom of the screen and the information that can be displayed in the center of the panel include details about:

- The functioning of the Bridge Program and the bridge adapters
- The configuration parameter settings currently being used by the Bridge Program (asterisks indicate which ones have been modified by the IBM LAN Manager)
- The traffic flowing through the bridge (performance)
- Links with network manager programs.

The bridge traffic information that can be displayed includes:

- The Path Trace Log

  Any frame passed across the bridge that has the system path trace request bit set on will cause an entry to be logged in the Path Trace Log. Entries can be displayed and cleared using the Bridge Program Path Trace panel.

- The performance counters and statistics

  The performance counters and statistics provide information about frames that are forwarded and not forwarded through the bridge.

  See "Bridge Performance Analysis" on page 13-6 for a description of the meaning and use of the Bridge Program performance information.

The IBM Token-Ring Network Bridge Program (Version 2.2)

The IBM Token-Ring Network Bridge Program Version 2.2 joins together two rings of an IBM Token-Ring Network, permitting communication between devices connected to different rings.

For local bridging, the IBM Token-Ring Network Bridge Program Version 2.2 requires a dedicated workstation (referred to in this discussion as the bridge computer), with two IBM Token-Ring Network adapters installed. The bridge computer is an attaching device on a lobe of each ring. The adapter cable for each bridge adapter must be able to reach an access unit connected to the appropriate ring. Therefore, the two access units must be located near each other and near the bridge device.

The Bridge Program uses source routing to transfer data between two rings of an IBM Token-Ring Network. Devices that support source routing can communicate through the bridge, even though they are attached to different rings.

As well as providing the means to transfer data between two rings, the Bridge Program provides:

- Ring status and error information (similar to that supplied by the Ring Diagnostic and the IBM LAN Manager) that can be used for problem determination.
- Bridge performance information that can help you evaluate and manage traffic flow through the bridge.
- Functions to allow up to four network manager programs (such as the IBM LAN Manager) to establish links with the Bridge Program, over which the Bridge Program can send ring status, adapter status, error information, and bridge performance information to the network manager programs.
- A self-test to see that the bridge is able to send and receive data on and across both rings.
- Support for two IBM Token-Ring Network adapters that are compatible with your bridge computer. These do not have to be the same type of adapter.
- Support for bridging two rings that are running at different data transfer rates. For example, a 4-Mbps ring and a 16-Mbps ring can be bridged.
- A spanning-tree protocol for automatic configuration of the single-route broadcast path.
- Remote bridging of two rings where the adapter cables of a single bridge computer cannot reach the access units of the rings. Remote bridging requires two bridge computers, each with an IBM Token-Ring Network adapter and a communications adapter. The two bridge computers are connected through external modems and a leased serial telecommunications line.
- Frame filtering to improve network performance and security.

In addition to the above functions, Version 2.2 of the Bridge Program provides:

- Support for local bridging of 8,144-byte frames and remote bridging of 4,472-byte frames between 16-Mbps rings.
- A remote dial feature for remote bridging over a public switched telephone network (PSTN). End stations use the provided Dial application to direct one

bridge half to call (or disconnect from) another bridge half. The bridge halves require external IEEE V.25bis switched modems.

Note: The bridges do not support the use of the IBM Token-Ring Network 16/4 Busmaster Server Adapter/A.

During Bridge Program installation, you will need to specify values or use the default values for:

- Bridge program installation parameters
- Bridge program configuration parameters
- Communication adapter configuration parameters (remote bridge function only).

Bridge Program (Version 2.2) Installation Parameters

The bridge installation parameters include some adapter configuration parameters usually specified in the IBM LAN Support Program configuration. However, the Bridge Program contains its own adapter support code and does not require the Support Program.

The Bridge Program *User's Guide* contains separate descriptions of the following parameters for the local and remote bridge functions. Their use with each function differs slightly. The following parameters must be specified during Bridge Program installation:

- Adapter name

  This parameter specifies the type of primary and alternate adapter installed in the bridge computer (for example, Adapter II, Adapter/A, or 16/4 Adapter). (This parameter applies to the local bridge function; the bridge adapter for each bridge half in a bridge using the remote bridge function is the primary adapter.)

- Adapter data rate

  This parameter specifies whether each ring operates at 4 or 16 Mbps.

- Locally administered address

  This parameter allows you to assign a locally administered address to each bridge adapter, to override the universally administered address. Each locally administered address must be unique on the network. See "IBM LAN Network Addressing" on page 1-25 for more about assigning locally administered addresses.

- Shared RAM address

  This parameter defines for each adapter the location in computer memory to be used for the RAM shared by the computer and the adapter. A different address must be used for each adapter that is installed in the same bridge computer. The defaults are recommended unless there is a specific and critical need to use other addresses.

Each shared RAM address must be located on a 16 KB boundary and is dependent upon the options installed in your computer. Each adapter's shared RAM address must not conflict with any of the following addresses:

- Shared RAM address of the other network adapter in the same bridge station
- ROM address of this bridge adapter
- ROM address of the other network adapter in the same bridge station
- The shared storage window address of the IBM X.25 Interface Co-Processor/2 Adapter or IBM Realtime Interface Co-Processor (for the remote bridge function only).

If you have a specific need to use values other than the defaults, refer to the *IBM Token-Ring Network Bridge Program User's Guide* and:

- For IBM Token-Ring Network adapters used in bridge computers with PC/IO Channel architecture (such as the IBM Token-Ring Network PC Adapter II and the IBM Token-Ring Network 16/4 Adapter), use the memory map in the adapter's *Guide to Operations* to select a value for this parameter.
- For IBM Token-Ring Network adapters used in bridge computers with Micro Channel architecture (such as the IBM Token-Ring Network Adapter/A and the IBM Token-Ring Network 16/4 Adapter/A), use the configuration information on the computer's Reference Diskette to determine and set the shared RAM address for each adapter.
- For the IBM Realtime Co-Processor, refer to the *IBM Realtime Co-Processor Guide to Operations* to select a value for the shared storage window address.
- For the IBM X.25 Interface Co-Processor/2 Adapter, use the configuration information on the reference diskette to set the shared storage window.

- Early Token Release

  Early Token Release is valid only for IBM Token-Ring Network adapters that support network data rates of both 4 and 16 Mbps as adapter configuration parameters. This option increases the utilization of the network by reducing the average time required for a network adapter to gain access to a token. It is automatically enabled when a 16/4 adapter's data rate is set to 16 Mbps. Early Token Release is ignored if the IBM Token-Ring Network segment operates at a data rate of 4 Mbps. See "Using Early Token Release with Bridges" on page 15-18 for more about using Early Token Release.

Bridge Program (Version 2.2) Configuration Parameters

Parameters that define functions of the bridge are set in a configuration file that you create before the Bridge Program is loaded. A configuration file provided on the diskette with the Bridge Program contains default parameters. A Configuration Program, supplied on the diskette with the Bridge Program, helps you alter the default values to meet the needs of your network.

The person preparing each Bridge Program working disk or diskette for your network will ask you or the network planner to provide a completed copy of the Bridge Planning Chart (see the *IBM Token-Ring Network Bridge Program User's Guide*), indicating any changes to the bridge configuration parameters.

Once set, all configuration parameters can be permanently changed by using the Configuration Program to alter the file again and restarting the Bridge Program. Some parameters can be changed by the IBM LAN Manager or LAN Network Manager. "Using Bridging Products with the IBM LAN Manager and the IBM LAN Network Manager" on page 15-20 indicates which parameters can be changed by each version of the IBM LAN Manager or LAN Network Manager.

The bridge configuration parameters are:

- Bridge number

  This parameter uniquely identifies a bridge to the Bridge Program when frames are forwarded through the bridge. The network administrator or planner assigns a bridge number to each bridge in the network. Multiple bridges spanning the same two LAN segments (that is, parallel bridges) **must** have different bridge numbers.

- LAN segment numbers

  These two parameters specify the 3-digit number used to identify to the adapter the LAN segment to which each bridge adapter is attached. For bridges using the local bridge function, the value for the LAN segment to which the primary adapter is attached must be different from the value for the LAN segment to which the alternate adapter is attached. For bridges using the remote bridge function, the value for the LAN segment to which the primary bridge half is attached must be different from the value for the LAN segment to which the secondary bridge half is attached.

  Note: All bridges connected to a specific LAN segment must refer to that LAN segment by the same number.

- Frame forwarding active

  This parameter indicates whether the Bridge Program is to begin passing frames through the bridge as soon as initialization is complete, or is to wait until a network manager program establishes a link with the bridge and turns on frame forwarding. (The IBM LAN Manager Version 2.0 and the IBM LAN Network Manager can turn bridge frame forwarding on and off; Version 1.0 does **not** contain function to turn bridge frame forwarding on and off.)

- Maximum frame size

  This parameter is for the remote bridge function only. For the local bridge function, the maximum frame size is automatically calculated, based on the capabilities of the installed adapters.

  This parameter specifies the largest frame (in bytes) that a bridge using the remote bridge function can process. The Bridge Program discards frames larger than the specified maximum frame size.

  Frame sizes greater than 2052 bytes can be set only if the Token-Ring Network 16/4 Adapter/A is installed in both bridge PCs. The token-ring adapters must have at least 32 Kb of memory to support frame sizes of 4472 bytes and 64 Kb of memory to support frames sizes of 8144 bytes.

Warning: If you are operating the bridge at lower line speeds, use special care when you configure the maximum frame size above 2052. At lower speeds, the smallest bit error rate could cause an excessive amount of data to be lost if the data is contained in large frames.

If you set the maximum frames size larger than 2052, you must have the proper token-ring adapters installed. Not all token-ring adapters can forward frames larger than 2052.

For a 4472-byte frame size, use either of the following adapters:

- Token-Ring Network 16/4 Adapter
- Token-Ring Network 16/4 Adapter/A

For 8144-byte frame size, use either of the following adapters:

- Token-Ring Network 16/4 Adapter configured for 16 Mbps
- Token-Ring Network 16/4 Adapter/A configured for 16 Mbps.

When you specify the default value of 0 for the maximum frame size parameter, the Bridge Program selects the default maximum frame size from the values shown in Table 15-9. The Bridge Program selects the default value shown for the line data rate of the telecommunications link connecting the two bridge computers.

Table 15-9. Maximum Frame Size Default Values Used by Bridge Program

Line Data Rate	Recommended Maximum Frame Size
9.6 Kbps $\leq$ D $<$ 38.4 Kbps	516 bytes
38.4 Kbps $\leq$ D $<$ 56 Kbps	1500 bytes
56 Kbps $\leq$ D $\leq$ 1344 Mbps	2052 bytes
D = 1344 Mbps	4472 bytes
Note: D = Line Data Rate	

If the maximum frame size sent to the bridge by an application program or device is smaller than the value shown in the table for a given line data rate, you can change the maximum frame size parameter value as follows:

Parameter Value	Maximum Frame Size
1	516 bytes
2	1500 bytes
3	2052 bytes
4	4472 bytes
5	8144 bytes

If a device or application program does not support a maximum frame size as small as the one shown for the given line data rate, you can:

- Try specifying the parameter value for the maximum frame size supported by the device or program (you should *not* do this for 9.6-Kbps links; consider using a higher line data rate instead).

- Consider using a telecommunications link with a higher line data rate for the bridge used by those devices or applications.

There are a number of factors, including maximum frame size, that you must consider in the configuration and use of a bridge that uses the remote bridge function. See "Considerations for Using the Remote Bridge Function" on page 13-40 for information about the parameters and variables to consider.

- Bridge performance threshold

  This parameter specifies the maximum allowable number of frames that are not forwarded through the bridge, per 10,000 frames arriving at the bridge, due to adapter congestion, a beaconing target ring, or invalid frames. Each time the threshold is exceeded, the Bridge Program counts a "threshold exceeded" occurrence in the Performance Statistics and sends a notification to any linked network manager programs.

  Note: The total number of frames arriving at the bridge and the total number of frames in error (excluding telecommunications link errors) are used for the remote bridge function to determine if the threshold has been exceeded. The total number of frames arriving at the bridge includes a count of frames filtered. The total number of frames in error (excluding telecommunications link errors) does not include this count. The count of frames filtered is not included in notifications to any linked network manager programs.

  Use the default value of 10 frames per 10,000 for the bridge performance threshold when you first install the bridge program. You may need to adjust the bridge performance threshold value over time to provide a better correlation between the occurrence of the threshold being exceeded and user perception of a problem in response time, data exchange, or application program operation.

  See "Bridge Performance Thresholds" on page 13-16 for more information about changing the bridge performance threshold value.

- Telecommunications link error threshold

  This parameter specifies the maximum allowable number of frames not received across a bridge, per 10,000 frames arriving at the bridge, due to errors on the telecommunications link connecting the two stations of a bridge using the remote bridge function. It expresses the number of frames forwarded onto the telecommunications link from one side of the bridge and not received by the other side of the bridge, before the Bridge Program counts a "threshold exceeded" occurrence in the Performance Statistics. The Bridge Program also sends a notification to any linked network manager programs that have requested such reports.

  Note: The count of frames filtered is not included in the calculation to determine if the threshold has been exceeded. Filtered frames are not forwarded onto the telecommunications link, and cannot be lost due to telecommunications link errors.

  The default telecommunications link error threshold values shown in Table 15-10 on page 15-66 were determined from calculations based on the following:

  - Line data rate of the telecommunications link between the two bridge stations
  - A line quality of 67% error-free seconds along with the corresponding approximate bit error rate.
  - Maximum average frame size that crosses the telecommunications link

    This value is the higher of the two frame size averages, one in each of the two directions across the bridge.

  If you know only the line data rate, and not the maximum average frame size crossing the bridge in both directions, do the following:

  1. Initialize the bridge the first time using the default telecommunications link error threshold value shown in Table 15-10 on page 15-66 for the line data rate used by the bridge.
  2. Run the bridge for approximately 24 hours to observe bridge operation and record the bridge performance counter values (bytes and frames forwarded counters) at intervals of at least 15 minutes.

     If your observation of bridge and network operation does not indicate that the threshold value is too high or too low, continue bridge operation with the default value.

     If, however, the operation of the bridge and the network indicate that the threshold value should be altered from the default, see "Bridge Performance Thresholds" on page 13-16 for instructions on how to determine the new value. You will need the bytes forwarded and frames forwarded counter values to determine the average frame sizes.

     - A threshold value set too low may cause an indication too often that the threshold was exceeded. The number of link errors occurring may not be sufficient to be causing lost user communication or other problems noticeable by the network users.

- A value set too high may not warn you soon or often enough that link errors are causing lost sessions or other problems noticeable by network users.

Once the bridge is installed and operating, a "threshold exceeded" occurrence for this threshold indicates one or more of the following conditions:

- The quality of the bridge telecommunications link may have degenerated below the given approximate bit error rate.
- The communication equipment used with the bridge is malfunctioning.
- The network has changed, altering the kind and/or amount of traffic crossing the bridge. The maximum average frame size may have changed enough to require a change in the threshold parameter value.

If you determine that you should change the threshold value from the default value, see the instructions in "Bridge Performance Thresholds" on page 13-16 for:

- How to use the counter values to determine the maximum average frame size for the bridge
- How to calculate a more accurate threshold value for this bridge, on the basis of the maximum average frame size and the line data rate.

Table 15-10. Default Values for the Telecommunications Link Error Threshold

If you have the following line data rate	**Then use the following default threshold value (frames/10,000)**	**Assumed maximum average frame size in bytes**	**Approximate bit error rate**
9.6 Kbps	**1581**	516	4.17×10^{-5}
19.2 Kbps	**815**	516	2.06×10^{-5}
38.4 Kbps	**1173**	1470	1.04×10^{-5}
56 Kbps	**1085**	2052	7×10^{-6}
64 Kbps	**972**	2052	6.23×10^{-6}
256 Kbps	**253**	2052	1.56×10^{-6}
512 Kbps	**127**	2052	7.83×10^{-7}
1.344 Mbps	**49**	2052	2.98×10^{-7}

The approximate bit error rates in this table are based on a % error-free-seconds value of 67%.

The formula used by the Bridge Program to calculate the telecommunications link error threshold assumes the values provided in this table for the maximum average frame size and the "worst case" approximate bit error rate.

- Restart on error

  This function causes the bridge computer to restart automatically, reload DOS, and reload the Bridge Program if an adapter check or a critical resource depletion occurs. If this function is used, all of the commands necessary to load the Bridge Program must be contained in an AUTOEXEC.BAT batch load file on the default drive. None of the commands must require operator intervention before the load continues (such as time or date requests).

  Automatic loading can be particularly useful if the device in which it runs is used only for the bridge (there would not be conflicting AUTOEXEC.BAT files on the default drive or a need for operator intervention at load time).

  Notes:

  1. If you use both the Restart on error and the Memory dump on error functions, the AUTOEXEC.BAT file must be located on the same drive specified for the Memory dump on error.
  2. Restart on error can be used with the remote bridge function, as long as the cause of the restart is a Bridge Program problem. If the telecommunications link or connecting communication equipment is malfunctioning, manual intervention will be required to restart the bridge.

- Drive for memory dump on error

  If a Bridge Program internal program error occurs, the Bridge Program writes a file containing an image (dump) of itself and its buffers from computer memory onto the fixed disk or diskette drive specified by this parameter. There must be sufficient space on the specified disk or diskette for the dump file.

  You will need to give instructions to the bridge operator for preserving the dump file and attempting to restart the Bridge Program:

  – You may need to give a copy of the dump file and a copy of your Bridge Program working disk or diskette to your service supplier if you cannot resolve the problem.

  – If the dump file is on the fixed disk or the Bridge Program working diskette, copy the file to a separate diskette before trying to restart the Bridge Program.

  – The last records in the ECCLOG.DAT file usually indicate the reason for the termination of the Bridge Program.

- Drive for error log

  This parameter specifies the fixed disk or diskette drive to be used to log in the ECCLOG.DAT file the messages generated when the Bridge Program terminates operation either by operator request or because of an adapter check or critical resource depletion.

  The file entries can provide problem determination information, particularly in cases where the bridge is unattended for long periods of time and uses **Restart on error** to reload the Bridge Program after an error causes it to terminate.

  The error log file (ECCLOG.DAT) is not erased from a disk or diskette when the Bridge Program is restarted. Entries are added to the file until the file is full. The Shutdown panel displays a message when the ECCLOG.DAT file fills up. You must then erase the file or supply a new diskette for the file before you restart the Bridge Program. If you need to save the information in the

ECCLOG.DAT file for problem determination, copy the file to another diskette before you erase the file, or print the file.

You can view the ECCLOG.DAT file using a text editor such as DOS EDLIN or IBM Personal Editor. However, you cannot use the editor on the bridge computer while the Bridge Program is running.

- Hop count limit

  This parameter specifies the number of consecutive bridges through which a broadcast frame may travel, including the current bridge.

  For the IBM Token-Ring Network Bridge Program Version 2.2, hop count applies only to broadcast frames (not to non-broadcast frames or to single-route broadcast frames).

  If the number of bridges the frame has passed through is equal to or greater than this hop count limit value, the frame will not be transmitted further.

- Parameter Server

  This parameter specifies for each LAN segment whether or not the Parameter Server functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Parameter Server provides the LAN segment number to an adapter when the adapter is attaching to the LAN segment, and sends a notification to one or more linked network manager programs when a new adapter has attached to the LAN segment.

  Note: If the bridge program reports to the IBM LAN Manager Version 2.0 or the IBM LAN Network Manager Version 1.0, you must enable the Parameter Server during bridge configuration. Otherwise, the communication link between the LAN Manager program and the bridge cannot be established.

- Error Monitor

  This parameter specifies for each LAN segment whether or not the Error Monitor functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Error Monitor does the following:

  - Compiles error statistics reported by adapters on either LAN segment
  - Analyzes the statistics to determine a probable cause of errors degrading network operation
  - Sends reports to indicate critical problems to the IBM LAN Manager programs that have requested reports
  - Updates the **LAN Segment Status** area of the Bridge Program panels to "Soft Error" when appropriate

  If the Error Monitor parameter value is **N (No)**, the Bridge Program will not display soft error information for that LAN segment. The error information on the Network Status Details panel will be zeros, and the LAN segment status "Soft Error" will not be displayed on the Bridge Program panels when soft errors occur.

  Note: If the Bridge Program reports to the IBM LAN Manager Version 2.0 or IBM LAN Network Manager Version 1.0, you must enable the error monitor by setting the parameter value to **Y (Yes)** during bridge configuration. Otherwise, the LAN Manager program will not be able to manage the LAN segment effectively.

- Configuration Report Server

  This parameter specifies for each LAN segment whether or not the Configuration Report Server functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Configuration Report Server sends notifications about the current active configuration of each LAN segment to each IBM LAN Manager that has a link established with the bridge, if the bridge Configuration Report Server functional address is enabled. It reports changes in NAUN addresses and active monitor on the LAN segment.

- Single-Route Broadcast

  This parameter specifies whether single-route broadcast frames are to be passed from one LAN segment to the other through the bridge computer. The IBM Token-Ring Network Bridge Program Version 2.2 allows you to choose either manual mode or automatic mode.

  - For manual mode, you must manually determine which bridges in your network should have single-route broadcast active, and set the single-route broadcast parameters to active or inactive for each individual bridge during bridge configuration.

    Note: If you choose the **M (Manual)** option, you should set the single-route broadcast parameter to manual for each bridge in your network.

  - For automatic mode, the bridge programs in your network automatically set and modify the single-route broadcast parameters for each bridge to compensate for changes in network configuration.

    It is recommended that you **do not use** the automatic mode of the single-route broadcast parameter when using the remote bridge function in the following situations:

    - When the bridge is in the only path connecting one LAN segment to another LAN segment

      Use manual mode and set the single-route broadcast parameters to **Y (Yes)** to prevent this LAN segment from being isolated from the network.

    - When the telecommunications link connecting the bridge computers has a low line data rate, such as 9.6 Kbps

      The messages generated by the automatic mode of single-route broadcast may cause the volume of traffic across the telecommunications link to be excessive.

    - When the bridge is connecting separately administered large LANs at different sites

      When using slower line data rates, such as 9.6 Kbps to connect the bridge halves, the number of bridges from the root bridge to the last bridge (including the root bridge) in a path should be no more than four. If there are more than four, messages from the root bridge may not reach the last bridge quickly enough. The last bridge may assume that a bridge in the path has left the network, and may try to start the process to reset the single-route broadcast parameters and bridge roles.

You may use the automatic mode of the single-route broadcast parameter for bridges on other LAN segments or networks on either side of the bridge using the remote bridge function depending upon the needs of your network.

For each bridge that uses automatic mode, you can specify or use default values for:

- A bridge label (a 2-byte identifier)
- A path cost increment.

Warning: The IBM Token-Ring Network Bridge Program Version 2.2, using the automatic mode of the single-route broadcast parameter, will not recognize the existence of the IBM Token-Ring Network Bridge Program Versions 1.0, 1.1, and 2.0 without PTF UR25531, or the IBM PC Network Bridge Program without PTF UR25532. This may cause the following problems:

- Some LAN segments may become isolated from the network.
- Some LAN segments may receive duplicate single-route broadcast frames.

If you have the IBM Token-Ring Network Bridge Program Version 2.2 and either of the bridge programs listed below in your network, and you want to use the automatic mode of the single-route broadcast parameters, you must use the following PTFs:

Table 15-11. PTF Numbers Required for Automatic Mode

Name of Bridge Program	**PTF Number**
IBM Token-Ring Network Bridge Program, Version 2.0	PTF UR25531 or later
IBM PC Bridge Program, Version 1.0	PTF UR25532 or later

Refer to the "Statement of Service" in the *IBM Token-Ring Network Bridge Program User's Guide Version 2.2* for information about obtaining PTF Numbers and other access to program service from your IBM representative. If you do not use the PTF with these bridges, you will **not** be able to use the automatic mode of the single-route broadcast parameter of these bridges with Version 2.2 in the same network.

See "Single-Route Broadcast" on page 15-6 for more information about using the single-route broadcast bridge function.

- Link passwords

  The Bridge Program uses these passwords to determine that an IBM LAN Manager or LAN Network Manager program is authorized to establish a communication link with the Bridge Program. The IBM LAN Manager and LAN Network Manager request and receive network management reports and notifications from the Bridge Program over the link. The controlling IBM LAN Manager or LAN Network Manager program (the program that established link 0) can change some Bridge Program configuration parameters in the bridge computer memory. Bridge configuration parameter values changed by the IBM LAN Manager or LAN Network Manager are recorded in the ECCPARMS.BIN file.

  The IBM LAN Manager or LAN Network Manager program must give a valid password when it is establishing a link or the link request will be rejected.

Note that if the bridge link password is not changed from the default (which is "00000000"), the IBM LAN Manager or LAN Network Manager link must use the password "00000000".

Up to four IBM LAN Manager or LAN Network Manager programs can concurrently establish a communication link with the Bridge Program. Each IBM LAN Manager or LAN Network Manager program must use a different one of the four link passwords.

The completed Bridge Planning Chart should show any link passwords used instead of the defaults. Give a copy of the passwords to the person doing configuration for the IBM LAN Manager or LAN Network Manager programs that will communicate with your bridge. Keep the Bridge Planning Chart in a secure place for future reference.

Remote Bridge Communications Adapter Configuration Parameters

The IBM Token-Ring Network Bridge Program Version 2.2 supports the remote bridge function. A communications adapter connects each station of a bridge using the remote bridge function to one end of a telecommunications link. Each bridge station forwards frames from one LAN segment to the other over the telecommunications link.

The bridge requires one communications adapter configuration file (ECCSBPRM.BIN) for **each half** of the bridge (primary and secondary bridge halves). You can use the Communications Adapter Configuration Program to specify communication adapter configuration parameter values for:

- Line data rate

  The line data rate is the speed at which the telecommunications link is to be clocked externally by a DCE (such as a modem) for data transfer. The telecommunications link operates at data rates from 9.6 Kbps to 1.344 Mbps.

- Electrical interface

  The electrical interface indicates what type of electrical interface is being used at the communications adapter DCE (V.24, V.35, or X.21).

- Communications adapter transmit buffer size

  The communications adapter transmit buffer size is the maximum number of bytes that can be in the communications adapter transmit queue at one time. For a default value of 0, the Bridge Program uses the value shown in Table 15-12 for the line data rate used by the link.

Table 15-12. Communications Adapter Transmit Buffer Size Default Values for Commonly Used Line Data Rates

Line Data Rate	Value
9.6 Kbps	1,100
19.2 Kbps	2,200
56 Kbps	6,417
64 Kbps	7,489
512 Kbps	56,320
1.344 Mbps	65,535

The Bridge Program communication adapter transmit buffer sizes were determined by using the formulas shown in Table 15-13 on page 15-72, with an IEEE 802.2 LLC T1 timer value of 1.1 seconds. The default values shown in the table are intended to maximize the utilization of the bridge when using the remote bridge function. The formula used depends upon the line data rate of the telecommunications link between the two bridge computers.

The IEEE 802.2 LLC T1 timer value is a parameter specified in device configuration or in program configuration or generation for the programs and devices that send frames across the bridge. The IEEE 802.2 LLC T1 timer value that should be used to calculate a value for the bridge communications adapter transmit buffer size is the smallest IEEE 802.2 LLC T1 timer value (specified or default) used by any station on the two LAN segments connected by the bridge. Use the same IEEE 802.2 LLC T1 timer value for both halves of the bridge.

You may need to change the communications adapter transmit buffer size if one or more of the following are true:

- The line data rate used by the bridge telecommunications link is different from any of those in Table 15-12 on page 15-71.
- The smallest IEEE 802.2 LLC T1 timer value used on the two LAN segments is not 1.1 seconds.

If you want to change the buffer size, use the appropriate formula from Table 15-13 to determine the correct buffer size to use. Change the buffer size in the communications adapter configuration and restart the bridge.

Table 15-13. Communications Adapter Transmit Buffer Size Formulas

Line Date Rate	Assumed Bit Error Rate	Formula or Value
9.6 Kbps $\leq$ D < 64 Kbps	10^{-5} or better	$N = \frac{D \times T1}{9.6}$
64 Kbps $\leq$ D < 512 Kbps	10^{-5} or 10^{-6}	$N = \frac{D \times T1}{9.4}$
512 Kbps $\leq$ D < 530 Kbps	10^{-6} or better	$N = \frac{D \times T1}{8.9}$
D $\geq$ 530 Kbps	10^{-6} or better	N = 65,535

Note:

N = Buffer limit in KB (**Note**: Here, K = 1000.)
D = Line data rate in Kbps
T1 = Timer value in seconds
(calculations for defaults use 1.1 seconds).

- Bridge Mode

  The bridge mode determines what method the bridge will use to connect to its other half. This parameter must be set the same for both bridge halves.

  If the telecommunication link between the bridge halves is a leased line, choose 1-Leased. If the bridge needs to dial a phone number to connect to its other half, choose 2-Switched. These parameters are discussed in Chapter 8 of the *IBM Token-Ring Network Bridge Program User's Guide Version 2.2*. See "Remote Dial Feature" on page 15-73 for information on the Remote Dial Feature.

Remote Dial Feature

The remote dial feature of the IBM Token-Ring Network Bridge Program Version 2.2 allows remote bridge configurations to use a public switched telephone network (Switched mode). Call signaling is accomplished through an external IEEE V.25bis modem.

When you configure for Switched mode, you must use a Dial application to:

- Request one bridge half to call another bridge half
- Receive call progress and completion status from a bridge half
- Request one bridge half to disconnect from another bridge half (the bridge halves will automatically disconnect if there is no data traffic for a configurable length of time).

The Dial application is executed in an IBM Token-Ring Network end station. Separate Dial applications are provided for the DOS and OS/2 operating systems (DIALDOS.EXE for DOS, DIALOS2.EXE for OS/2).

The Dial application and a bridge half communicate using SAP X'F4'. Call and disconnect requests are transmitted by the Dial application to a bridge half's MAC address as single-route broadcast 802.2 LLC type 1 frames.

A bridge half that receives a Call request directs the attached modem to dial a remote bridge half's phone number. When the call has been completed, the bridge halves join to form one bridge.

A bridge half that receives a Disconnect request directs the attached modem to disconnect the call. The bridge halves remain idle until another Call request is received.

Responses to Call and Disconnect requests are transmitted by the bridge half to the Dial application as non-broadcast (specific route) 802.2 LLC type 1 frames. The Dial application uses information in the responses to display call progress and disconnect status messages for the operator.

The use of remote dial assumes that you do not want the IBM LAN Manager or the LAN Network Manager to be linked to the bridge while it is in the disconnected state. The IBM LAN Manager or the LAN Network Manager cannot manage remote segments through the bridge if the communications link is down.

It also assumes that you do not want to maintain any links through the bridge once the bridge halves are disconnected. All communication through the bridge ceases when the bridge halves disconnect.

Configuration Parameters

The following parameters are manually configured on each bridge half when you run the Communications Adapter Bridge Configuration Program (ECCSBCF.EXE). Refer to the procedures in Chapter 8 of the *IBM Token-Ring Network Bridge Program User's Guide Version 2.2*.

- Bridge Mode

  The bridge mode defines what type of telecommunications line the bridge should use. “Leased” instructs the bridge to use a leased telecommunications line. “Switched” instructs the bridge to use a public switched telephone network. If you select "Switched," the following parameters must also be configured.

- Dial Password

  When the bridge half receives a call or disconnect request from a Dial application, it compares the password contained in the request frame with the configured Dial password. If the passwords match, the bridge half will proceed with the request.

  The default password is blank. If the password is left blank, the bridge half will not check the password when it receives a call or disconnect request.

- Dial Mode

  The dial mode is used to define whether the bridge half can call another bridge half or answer calls from another bridge half. If you select "originate only," the bridge half can call another bridge half but cannot answer calls. If you select "answer only," the bridge half can answer calls but cannot call another bridge half. If you select "answer or originate," the bridge half can answer a call from another bridge half or call another bridge half.

- Call Establishment Method

  The call establishment method determines what type of dial command the bridge half will issue to the modem. "Dial with number" instructs the bridge half to use the phone number provided by a Dial application. "Dial with identify" instructs the bridge half to use the phone number and call identification string provided by a Dial application. "Dial with DCE number" instructs the bridge half to use the phone number that has been manually stored in the modem.

  A Dial application must be used to tell the bridge half to originate the call. This is true for every type of call establishment method.

- Remote Dial Timing Parameters

  These parameters are used to customize the auto-dial and auto-answer operation. (Except for T9, any number from 0 to 3600 can be specified.) If you change the default values, make sure that you use reasonable values, or poor response time and performance may result. Also, make sure that the values you choose conform to the regulations of the national telephone administration for the country in which the remote bridge is operated.

Remote Dial Definitions

In switched mode, in order to transfer data between rings, the halves must first connect and initialize. When the bridge halves disconnect, the bridge halves remain idle. This section describes the processes of connection, initialization, and disconnection (idle).

Connection: The Dial application controls when the bridge halves connect. The Dial application sends a request frame to a bridge half containing a request correlator, call request, dial password, and optional phone number.

When a call request frame is received, the bridge parses the frame to see if a connection should be made between two halves. If the password is accepted and the bridge is not already connected, the bridge half commands the modem to dial the phone number.

When the connection is established (or if the connection cannot be established), the bridge half sends the response frame to the Dial application. The Dial application uses information in the response frame to display call progress or error messages for the operator.

Initialization: When the connection is established, the bridge halves join to become one bridge. Bridge initialization occurs when the primary bridge half sends its configuration file to the secondary bridge half. The secondary bridge half uses the information in the file to configure itself.

The initialization is performed each time a connection is established between the primary and secondary bridge halves.

Disconnection: The bridge halves remain idle when they are disconnected. When idle, the bridge halves do not forward traffic but wait to receive a Dial application call request or answer an incoming call. The bridge halves disconnect when:

- No data has been transferred for a configured time period (the data inactivity timer T8, configured using the Communications Adapter Bridge Configuration Program).
- One of the bridge halves receives a Disconnect request from a Dial application. This method should be used if T8 has been configured to zero (0).
- One of the bridge halves detects a line error condition.

Dial Application

When you configure for Switched mode, you must use the Dial application to:

- Request one bridge half to call another bridge half
- Receive call progress and completion status from a bridge half
- Request one bridge half to disconnect from another bridge half (the bridge halves will automatically disconnect if there is no data traffic for a configurable length of time).

The Dial application is executed in an IBM Token-Ring Network end station. Separate Dial applications are provided for the DOS and OS/2 operating systems (DIALDOS.EXE for DOS, DIALOS2.EXE for OS/2).

The operator can use either a menu or command line interface to specify the following parameters to the Dial application:

- Request type (Call, Disconnect)
- Adapter type (Primary, Alternate)
- Bridge adapter address
- Password (optional)
- Phone number (optional).

The Dial application and a bridge half communicate using SAP X′F4″. Call and Disconnect requests are transmitted by the Dial application to a bridge half's MAC address as single-route broadcast 802.2 LLC type 1 frames.

A bridge half that receives a Call request directs the attached modem to dial a remote bridge half's phone number. When the call has been completed, the bridge halves join to form one bridge.

A bridge half that receives a Disconnect request directs the attached modem to disconnect the call. The bridge halves remain idle until another Call request is received.

Responses to Call and Disconnect requests are transmitted by the bridge half to the Dial application as non-broadcast (specific route) 802.2 LLC type 1 frames. The Dial application uses information in the responses to display call progress and disconnect status messages for the operator.

The Dial application is provided with the Bridge Program on the Remote Dial diskette. Refer to Chapter 8 of *IBM Token-Ring Network Bridge Program User's Guide Version 2.2* and the DIALDOC.DPF file provided on the Remote Dial diskette for information about using the Dial application and writing your own dial application.

Filter Programs

You can use filter programs with the IBM Token-Ring Network Bridge Program Version 2.2 to limit the traffic that can cross a bridge.

You may want to limit bridge traffic for the following reasons:

- Network performance

  This can be an important consideration for bridges using remote bridge telecommunications links with line data rates (such as 9.6 Kbps) that are much lower than LAN and local bridge data transmission rates. The application programs on a LAN segment may be able to send data to a bridge that uses the remote bridge function faster than the bridge can process frames and transfer them over the link to the other LAN segment. You may want to limit the number of pairs of users that can exchange information at one time across a bridge that uses the remote bridge function.

- Network security

  You can use a filter program to permit only certain adapter addresses to send files across a bridge (to a particular file server or print server, for example).

Filter programs can limit the traffic that can cross a bridge in a number of ways, including:

- Restricting the number of pairs of users exchanging information across the bridge at one time
- Forwarding or filtering frames from specific adapter addresses
- Forwarding or filtering frames with certain values in specific fields.

Use of filter programs with the Bridge Program is optional. You may choose to use filter programs to limit the traffic crossing some or all bridges in the network that use the IBM Token-Ring Network Bridge Program Version 2.2. You need to consider:

- What traffic needs to cross each bridge that uses the IBM Token-Ring Network Bridge Program Version 2.2 in your network
- Whether you need to use one or more filter programs to limit the traffic crossing one or more bridges.

You can use up to 10 filter programs with:

- Each half of a bridge using the remote bridge function (primary and secondary half)
- Each adapter of a bridge using the local bridge function (primary and alternate adapter).

Each bridge half or adapter does not have to use the same filter programs. Filtering is done only for frames sent to the bridge on the source LAN segment, to determine whether to forward the frames across the bridge to the destination LAN segment. Frames that have been forwarded across the bridge are not filtered as they arrive at the side of the bridge connected to the destination LAN segment.

IBM-Supplied Filter Programs

The *IBM Token-Ring Network Bridge Program User's Guide* for Version 2.2 describes the function, installation, and use of the three filter programs supplied on the Bridge Program diskette. Here is a brief description of those programs:

- The **link limiting filter program**, FILTER1.COM, which limits the number of pairs of adapter addresses that can exchange information at one time through a bridge using the remote bridge function. This filter program can be used **only** with the remote bridge function.

  The link limiting filter program can help limit the traffic crossing the telecommunications link connecting the two bridge halves by limiting the number of pairs of unique source and destination addresses that can exchange information at one time through the bridge.

  If the bridge telecommunications link uses a low data rate, such as 9.6 Kbps, you may want to use this filter program. The line data rate of the telecommunications link (9.6 Kbps) is slower than that of the LAN segments connected by the bridge halves (4 or 16 Mbps). The application programs on a LAN segment may be able to send data to a bridge using the remote bridge function faster than the bridge can process frames and transfer them over the link to the other LAN segment.

- The **NETBIOS filter program**, FILTER2.COM, helps limit the proliferation of NETBIOS frames crossing a bridge from one LAN segment to the other. This filter program can be used with both the remote and the local bridge functions. This filter program makes a filtering decision based on NETBIOS names and frame types. The NETBIOS filter program maintains a table of NETBIOS names. You can specify:

  - A single name in the NAME load command parameter.
  - A list of names in a file; you specify the name of the file in the FILE load command parameter.

  The filter program compares the names in the table with the source name field or the destination name field in the frame's NETBIOS header. A load command parameter indicates the action to be taken with frames for which there is a name match in the table.

- The **adapter address filter program**, FILTER3.COM, which filters (discards) all frames that contain source and destination addresses (a single pair of addresses, or a range of source addresses and a range of destination addresses) specified on the filter program load command. This filter program can be used with both the remote and the local bridge functions.

  You can use locally administered adapter addresses to make sure that the adapter addresses for which frames are to be filtered are within the specified range, and that adapter addresses that can send frames across the bridge are outside the specified range. You can do the following:

1. Assign a locally administered address within the desired range to each adapter that is **not** allowed to send and receive frames across the bridge.
2. Verify that the addresses used for adapters that **can** send frames across the bridge are outside the desired range. If any fall within the range, assign a locally administered address outside the range for those adapters.

Designing, Writing, and Using Your Own Filter Programs

If you want to use filter programs with the bridge, other than or in addition to the three filter programs supplied on the Bridge Program diskette, you must design and write your own.

The *IBM Token-Ring Network Bridge Program User's Guide* for Version 2.2 contains instructions for writing, assembling, and producing an executable module of a filter program.

Because the filter programs are called for every frame received at a bridge, each filter program should be as small as possible and execute as efficiently as possible. The performance of the bridge could become very dependent on the performance of the filter programs.

Designing Your Own Filter Programs

When designing your own filter Programs, you need to:

- Determine the need for the use of filter programs with the bridges that use the IBM Token-Ring Network Bridge Program Version 2.2 in your network.

  Consider particularly:

  - Bridges using the remote bridge function and telecommunications links with lower line data rates
  - NETBIOS traffic across bridges using the remote bridge function
  - Any security reasons for limiting access to services on a LAN segment (such as print or file servers)

  Consider the characteristics of the traffic that would cross each bridge (for example, frame types and size and frequency of file and message transfer), number and duration of active sessions between users across a bridge, and location of sending stations (filter programs need to be used with the bridge adapter or remote bridge half connected to the LAN segment containing the sending stations).

- Determine the criteria by which each filter program decides to either filter (discard) a frame or forward the frame across the bridge.

  The criteria can be a range of addresses, a number of pairs of source and destination addresses that can exchange information at one time, a value in some portion in the Information field, or a combination of criteria.

  For multiple filter programs, give consideration to whether one filter program should stop the filtering process when it decides to filter a frame (not letting subsequent filters see the frame). Consider also whether a filter program can have the capability to override a previous program's decision to filter a frame.

There are some differences between the filter programs that you write and the filter programs provided on the Bridge Program diskette. You need to consider those differences in designing your own filter programs and in using your filter programs with one or more of the supplied filter programs for the same local bridge adapter or remote bridge half.

- The three filter programs supplied on the Bridge Program diskette do **not** provide or recognize the pass-on flag. The frame will always be passed to the next filter program after one of the three filter programs has checked the frame.
- The three filter programs supplied on the Bridge Program diskette do **not** change the filter flag once it indicates a decision to filter a frame. The three filter programs check the filter flag upon receiving a frame. If the filter flag indicates to filter the frame, the three filter programs immediately return control to the adapter support code. The frame is then passed to the next, if any, filter program with the filter flag unchanged.
- The three filter programs allow the user to specify or omit the load parameter CONT.

  Omitting the parameter CONT causes Bridge Program initialization to pause if the filter program does not load and initialize successfully. A prompt is displayed which allows the user to see the error message and requests that the user press any key to continue executing the batch file commands. Once the batch file has resumed execution, the user may stop the batch file by pressing Ctrl-Break to return to the DOS prompt.

  Specifying the CONT parameter causes Bridge Program initialization to continue even if the filter program does not load and initialize successfully. You should use the CONT parameter for bridges that use the **Restart on error** function to automatically restart the bridge without operator intervention when an internal bridge error or critical resource depletion occurs.

Writing Your Own Filter Programs
Each filter program that you write has two major parts:

- Initialization

  In order to load when the Bridge Program loads, establish communication with the Bridge Program adapter support code, and remain resident in computer memory while the Bridge Program is running, the initialization portion of your filter program must include the following functions:

  1. Read and validate input data such as load parameters, if any.
  2. Issue a DIR.SET.FILTER.APPENDAGE CCB to the Bridge Program adapter support code. The CCB format is shown in the Bridge Program *User's Guide*.
  3. Check the return code upon return from the CCB command. Indicate to the bridge operator in some way any errors in the CCB format or any errors that occurred in loading the filter program.
  4. End initialization by terminating the filter program but having it stay resident.

- Frame filtering

  The frame filtering portion of each filter program should include the following functions:

- Establish the criteria upon which to base the decision to forward or filter a frame.
- Locate the fields in the frame to use in making the decision.
- Compare the fields to the criteria, and make the decision.
- When the decision to forward or not forward the frame across the bridge has been made, set the result of the decision in the filter flag and set the pass-on flag to indicate whether the frame is to be passed to the next filter program (if any).
- Return control to the Bridge Program.

The adapter support code passes the filter flag just as it is from one filter program to the next one, and does not check the filter flag until after the last filter program has been called or until the pass-on flag indicates not to pass the frame to any other filter programs. If one filter program indicates that a frame should be filtered, a subsequent filter program can choose to:

- Check the filter flag upon entry, and return control to the Bridge Program immediately when the flag indicates that the frame is to be filtered.
- Continue checking criteria, and may override a previous filter program's decision to filter a frame.

Using Your Own Filter Programs
For each filter program that you design, you must:

- Write the program in a source language that is supported by DOS.
- Assemble the source module to obtain an object module.
- Link the object module to obtain an executable module of the program.
- Install the executable filter program module (and a parameter file, if required) on the Bridge Program working disk directory or diskette.
- Insert a load command with the name of the filter program and any load parameters into the FILTER.BAT file on the working disk or diskette.

The Bridge Program *User's Guide* contains specifications for writing your filter programs, instructions for preparing them for use, and installation instructions. The software installation steps described in the Bridge Program *User's Guide* help you to install the supplied and user-written filter programs on your Bridge Program working diskette or disk. The installation steps include:

- Putting the executable modules of the filter programs on the working disk or diskette in the sub-directory from which the Bridge Program is loaded.
- Inserting the file names of the filter programs with appropriate load parameters as load commands in the FILTER.BAT file in the working disk or diskette sub-directory from which the Bridge Program is loaded. (You decide whether the filter programs you write require or accept load parameters. The *User's Guide* describes the load command parameters for the three filter programs supplied on the Bridge Program diskette.)

  You insert the file names of the filter programs in the reverse of the order you want the Bridge Program to use them. The filter program whose name is listed last in the FILTER.BAT file receives control first.

The filter programs and the Bridge Program load at the same time. The filter programs run whenever the Bridge Program is running.

Once the filter programs are installed and loaded with the Bridge Program:

- Each time the bridge adapter receives a frame, the adapter support code included with the Bridge Program begins passing control to (calling) the filter programs. Each filter program called by the Bridge Program adapter support code decides whether the frame should be filtered (discarded). The adapter support code calls filter programs, in the reverse of the order in which they were loaded, until the last program is called or until a filter program indicates not to pass the frame on to the next filter program.
- The adapter support code does not check to see whether a frame should be filtered until there are no more filter programs that need to check the frame.
- The Bridge Program forwards or discards the frame according to the setting of the filter flag after the filter programs have completed the check of the frame. A subsequent filter program can override the decision of an earlier filter program on whether to forward or discard the frame.

If you decide to stop using a filter program, you must do the following:

1. Shut down the Bridge Program.
2. Delete the filter program load command from the FILTER.BAT file in the Bridge Program sub-directory.
3. Turn off the bridge computer power for at least 15 seconds. Then, turn the bridge computer power back on.
4. Restart the Bridge Program.

Bridge Program (Version 2.2) Output

The Bridge Program displays status and error information about:

- Each ring connected to the bridge
- The adapters in the bridge computer
- The functioning of the Bridge Program itself
- Any links to network manager programs.

Panels contain the displayed information, and allow selection of Bridge Program functions.

The status of each of the two rings (LAN segments) that are connected by the bridge is shown on the bottom line of the screen. The center of the bottom of the screen also shows the status of the telecommunications link connecting the two halves a bridge that uses the remote bridge function. The line above the LAN segment status line indicates which function keys are currently active. The line above the function key indicators is used to display any messages that occur while the panel is being displayed. The center of the panel contains possible function selections, a display of information requested by the operator, or information to help you use the bridge functions.

LAN Segment Status

The status of each of the two rings is shown on the bottom line of the screen, one on the left and one on the right:

Normal: The LAN segment is operating normally.

Adapter Closed: This IBM Token-Ring Network adapter used by the bridge is no longer logically attached to the LAN segment.

Soft Error: The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly.

Wire Fault: There is a problem between the bridge computer's network adapter and the access unit to which it is connected. The network adapter, the cable from the network adapter to the access unit, or the access unit could be the source of the problem. The network adapter in the bridge computer is closed.

Beaconing: The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating the network within a predefined time limit.

Network status details can be requested and displayed on a panel. These details show the most recent soft error and beaconing condition for each ring. And they show the portion of the ring most likely to contain the error (the *fault domain*).

Telecommunications Link Status
One of two telecommunications link status conditions may be displayed in the center of the bottom of the screen at each bridge half:

- **Normal**: The telecommunications link is functioning normally.
- **Down**: The telecommunications link cannot be used for bridge communication; either the link needs to be activated or a problem needs to be resolved.

Bridge Program Status
The messages near the bottom of the screen and the information that can be displayed in the center of the panel include details about:

- The functioning of the Bridge Program and the bridge adapters
- The configuration parameter settings currently being used by the Bridge Program (asterisks indicate which ones have been modified by the IBM LAN Manager)
- The traffic flowing through the bridge (performance)
- Links with network manager programs.

The bridge traffic information that can be displayed includes:

- The Path Trace Log

  Any frame passed across the bridge that has the system path trace request bit set on will cause an entry to be logged in the Path Trace Log. Entries can be displayed and cleared using the Bridge Program Path Trace panel.

- The performance counters and statistics

  The performance counters and statistics provide information about frames that are forwarded and not forwarded through the bridge.

  See "Bridge Performance Analysis" on page 13-6 for a description of the meaning and use of the Bridge Program performance information.

The IBM PC Network Bridge Program

The IBM PC Network Bridge Program joins together:

- Two IBM PC Network segments
- One IBM PC Network segment and one IBM Token-Ring Network segment, or
- Two IBM Token-Ring Network segments.

The Bridge Program requires a dedicated workstation (referred to in this discussion as the bridge computer), with two LAN adapters installed. The Bridge computer is an attaching device on each LAN segment. Broadband and baseband IBM PC Networks are supported, and 4- and 16-Mbps IBM Token-Ring Networks are supported.

The Bridge Program uses source routing to transfer data between the two LAN segments. Devices that support source routing can communicate through the bridge, even though they are attached to different LAN segments.

As well as providing the means to transfer data between two segments, the Bridge Program provides:

- LAN status and error information that can be used for problem determination
- Bridge performance information that can help you evaluate and manage traffic flow through the bridge
- Functions to allow up to four network manager programs (such as the IBM LAN Manager) to establish links with the Bridge Program, over which the Bridge Program can send LAN status, adapter status, error information, and bridge performance information to the network manager programs
- A self-test to see that the bridge is able to send and receive data on and across both LAN segments
- Support for bridging two LAN segments that are running at different data transfer rates
- A spanning-tree protocol for automatic configuration of the single-route broadcast path.

Note: The bridges programs do not support the use of the IBM Token-Ring Network 16/4 Busmaster Server Adapter/A.

During Bridge Program installation, you will need to specify values or use the default values for:

- Bridge program installation parameters
- Bridge program configuration parameters.

IBM PC Network Bridge Program Installation Parameters

The bridge installation parameters include some adapter configuration parameters usually specified in the IBM LAN Support Program configuration. Because the Bridge Program contains its own adapter support code and does not require the Support Program, the following parameters must be specified during Bridge Program installation:

- Adapter name

  This parameter specifies the type of primary and alternate adapter installed in the bridge computer (for example, Adapter II, Adapter/A, or 16/4 Adapter).

- Adapter data rate

  This parameter specifies whether each LAN segment operates at 4 or 16 Mbps.

- Locally administered address

  This parameter allows you to assign a locally administered address to each bridge adapter, to override the universally administered address. Each locally administered address must be unique on the network. See "IBM LAN Network Addressing" on page 1-25 for more about assigning locally administered addresses.

- Shared RAM address

  This parameter applies to IBM Token-Ring Network adapters only.

  This parameter defines for each adapter the location in computer memory to be used for the RAM shared by the computer and the adapter. A different address must be used for each adapter. The defaults are recommended unless there is a specific and critical need to use other addresses.

  Each shared RAM address must be located on a 16-KB boundary and is dependent upon the options installed in your computer. Each adapter's shared RAM address must not conflict with any of the following addresses:

  - Shared RAM address of the other network adapter in the same bridge station
  - ROM address of this bridge adapter
  - ROM address of the other network adapter in the same bridge station

  If you have a specific need to use values other than the defaults, refer to the *IBM PC Network Bridge Program User's Guide* and:

  - For the IBM Token-Ring Network PC Adapter II and the IBM Token-Ring Network 16/4 Adapter, use the memory map in the adapter's *Guide to Operations* to select a value for this parameter.
  - For the IBM Token-Ring Network Adapter/A and the IBM Token-Ring Network 16/4 Adapter/A, use the configuration information on the computer's Reference Diskette to determine and set the shared RAM address for each adapter.

- Early Token Release

  Early Token Release is valid only for IBM Token-Ring Network adapters that support network data rates of both 4 and 16 Mbps as adapter configuration parameters. This option increases the utilization of the network by reducing the average time required for a network adapter to gain access to a token. It is automatically enabled when a 16/4 adapter's data rate is set to 16 Mbps. Early Token Release is ignored if the IBM Token-Ring Network segment operates at a data rate of 4 Mbps.

  See "Using Early Token Release with Bridges" on page 15-18 for more about using Early Token Release with the Bridge Program.

IBM PC Network Bridge Program Configuration Parameters

Some parameters that define functions of the bridge are set in a configuration file before the Bridge Program is loaded. A configuration file provided on the diskette with the Bridge Program contains default parameters. A Configuration Program, supplied on the diskette with the Bridge Program, helps you alter the default values to meet the needs of your network.

The person preparing each Bridge Program working disk or diskette for your network will ask you or the network planner to provide a completed copy of the Bridge Planning Chart (see the *IBM PC Network Bridge Program User's Guide*), indicating any changes to the bridge configuration parameters. Once set, the configuration parameters can be permanently changed by using the Configuration Program to alter the file again and restarting the Bridge Program. Some parameters can be changed by the IBM LAN Manager or the LAN Network Manager. "Using Bridging Products with the IBM LAN Manager and the IBM LAN Network Manager" on page 15-20 indicates which parameters can be changed by each version of the IBM LAN Manager or the LAN Network Manager.

The bridge configuration parameters are:

- Bridge number

  Each bridge is assigned a number that will be used for routing frames. Multiple (parallel) bridges joining the same two LAN segments must not duplicate a bridge number.

- LAN segment numbers

  Each LAN segment that is connected by a bridge is assigned a LAN segment number, which must be unique across the network. This parameter indicates to each adapter the number of the LAN segment to which it is attached.

- Frame forwarding active

  This parameter indicates whether the Bridge Program is to begin passing frames through the bridge as soon as initialization is complete, or is to wait until a network manager program establishes a link with the bridge and turns on frame forwarding. (The IBM LAN Manager Version 2.0 and the IBM LAN Network Manager can turn bridge frame forwarding on and off; Version 1.0 does **not** contain function to turn bridge frame forwarding on and off.)

- Bridge performance threshold

  This parameter sets the maximum number of frames that are not forwarded through the bridge, per 10,000 frames received at the bridge, before a "threshold exceeded" performance statistic is generated, recorded by the Bridge Program and sent to any linked network manager programs.

- Restart on error

  This function causes an automatic reloading of programs into the computer if an adapter check or a critical resource depletion occurs. If this function is used, all of the commands necessary to load the Bridge Program must be contained in an AUTOEXEC.BAT batch load file on the default drive. None of the commands must require operator intervention before the load continues (such as time or date requests). Automatic loading can be particularly useful if the device in which it runs is used only for the bridge (there would not be conflicting AUTOEXEC.BAT files on the default drive, or a need for operator intervention at load time).

Note: If you use both the Restart on error and the Memory dump on error functions, the AUTOEXEC.BAT file must be located on the same drive specified for the Memory dump on error.

- Drive for memory dump on error

  This parameter specifies the fixed disk or diskette drive to be used to write an image of the IBM PC Network Bridge Program memory and buffers on a disk or diskette if an internal program error occurs. There must be sufficient space on the specified disk or diskette for the dump file. You will need instructions to tell the operator what to do with the dump file, and how to restart the Bridge Program if it is possible to do so.

- Drive for error log

  This parameter specifies the fixed disk or diskette drive to be used to log the messages generated when the Bridge Program terminates operation either by operator request or because of an adapter check or critical resource depletion.

  The error log file (ECCLOG.DAT) must be erased and the Bridge Program restarted to clear the file when it fills up. A text editor must be used to display the contents of the file.

- Hop count limit

  For each adapter, a hop count limit is entered. The hop count is the number of bridges that broadcast frames received from the LAN segment attached to this adapter have already crossed. Broadcast frames whose hop count is equal to or higher than the receiving adapter's hop count limit are not permitted to cross the bridge. For the IBM PC Network Bridge Program, hop count applies only to broadcast frames (not to non-broadcast frames or to single-route broadcast frames).

- Single-route broadcast

  This parameter specifies whether single-route broadcast frames are to be passed from one LAN segment to the other through the bridge computer. The IBM PC Network Bridge Program allows you to choose either manual mode or automatic mode.

  - For manual mode, you must manually determine which bridges in your network should have single-route broadcast active, and set the single-route broadcast parameters to active or inactive for each individual bridge during bridge configuration.
  - For automatic mode, the bridge programs in your network automatically set and modify the single-route broadcast parameters for each bridge to compensate for changes in network configuration.

    For each bridge that uses automatic mode, you can specify or use default values for:

    - A bridge label (a 2-byte identifier)
    - A path cost increment.

  See "Single-Route Broadcast" on page 15-6 for more information about using the single-route broadcast bridge function.

- Parameter server

  This parameter specifies for each LAN segment whether or not the Parameter server functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

The Parameter server provides the LAN segment number to an adapter when the adapter is attaching to the LAN segment, and sends a notification to one or more network manager programs when a new adapter has attached to the LAN segment.

Note: If the bridge program reports to the IBM LAN Manager Version 2.0 or the IBM LAN Network Manager, you must enable the parameter server during bridge configuration. Otherwise, the communication link between the IBM LAN Manager and the bridge cannot be established.

- Error Monitor

  This parameter specifies for each LAN segment whether or not the Error Monitor functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Error Monitor does the following:

  - Compiles error statistics reported by adapters on either LAN segment
  - Analyzes the statistics to determine a probable cause of errors degrading network operation
  - Sends reports to indicate critical problems to the IBM LAN Manager or LAN Network Manager programs that have requested reports
  - Updates the **LAN Segment Status** area of the Bridge Program panels to "Soft Error" when appropriate.

  If the Error Monitor parameter value is **N (No)**, the Bridge Program will not display error information for that LAN segment. The error information on the Network Status Details panel will be zeros, and the LAN segment status "Soft Error" will not be displayed on the Bridge Program panels when soft errors occur.

- Configuration report server

  This parameter applies to IBM Token-Ring Network adapters only.

  This parameter specifies for each LAN segment whether or not the Configuration Report Server functional address is enabled; that is, whether the Bridge Program will copy and process frames destined for this function.

  The Configuration Report Server sends notifications about the current active configuration of each LAN segment to the IBM LAN Manager or LAN Network Manager programs that request reports. It reports changes in NAUN addresses and active monitor on the LAN segment.

- Link passwords

  The Bridge Program uses these passwords to determine that an IBM LAN Manager or LAN Network Manager program is authorized to establish a communication link with the Bridge Program. The IBM LAN Manager and LAN Network Manager request and receive network management reports and notifications from the Bridge Program over the link. The controlling IBM LAN Manager or LAN Network Manager program (the program that established link 0) can change some Bridge Program configuration parameters in the bridge computer memory. Bridge configuration parameter values changed by the IBM LAN Manager or LAN Network Manager are recorded in the ECCPARMS.BIN file.

  The IBM LAN Manager or LAN Network Manager program must give a valid password when it is establishing a link or the link request will be rejected.

Note that if the bridge link password is not changed from the default (which is "00000000"), the IBM LAN Manager or LAN Network Manager link must use the password "00000000".

Up to four IBM LAN Manager or LAN Network Manager programs can concurrently establish a communication link with the Bridge Program. Each IBM LAN Manager or LAN Network Manager program must use a different one of the four link passwords.

The completed Bridge Planning Chart should show any link passwords used instead of the defaults. Give a copy of the passwords to the person doing configuration for the IBM LAN Manager or LAN Network Manager programs that will communicate with your bridge. Keep the Bridge Planning Chart in a secure place for future reference.

IBM PC Network Bridge Program Output

The Bridge Program displays information about:

- Each LAN segment connected to the bridge
- The adapters in the bridge computer
- The functioning of the Bridge Program itself
- Any links to network manager programs.

Panels contain the displayed information, and allow selection of Bridge Program functions.

The status of each of the two LAN segments that are connected by the bridge is shown on the bottom line of the screen. The line above the LAN Segment Status line indicates which function keys are currently active. The line above the function key indicators is used to display any messages that occur while the panel is being displayed. The center of the panel contains possible function selections, a display of information requested by the operator, or information to help you use the bridge functions.

LAN Segment Status

The status of each of the two LAN segments is shown on the bottom line of the screen, one on the left and one on the right:

Normal: The LAN segment is operating normally.

Adapter Closed: This network adapter used by the bridge is no longer logically attached to the LAN segment.

Soft Error: The LAN segment is experiencing intermittent failures that cause data to be transmitted on the network more than once to be received correctly.

Wire Fault: (IBM Token-Ring Network segment only) There is a problem between the bridge computer's network adapter and the access unit to which it is connected. This network adapter, the cable from this network adapter to the access unit, or the access unit could be the source of the problem. This network adapter in the bridge computer is closed.

Beaconing: (IBM Token-Ring Network segment only) The LAN segment is inoperative. The network is experiencing an error condition detected by an adapter when there is either signal loss (possibly caused by a broken line) or no token is circulating the network within a predefined time limit.

Continuous Carrier: (IBM PC Network segment only) This IBM PC Network adapter or the modem on the adapter is in a continuous transmit mode. No other IBM PC Network adapters can transmit until the problem is resolved.

The bus is inoperative. The bus can automatically recover if the problem adapter removes itself.

No Carrier: (IBM PC Network segment only) There is no carrier signal on the LAN segment. A cable located between the Bridge computer and the translator unit is loose or broken, or there is a problem in the translator unit such as no power. On a remote LAN segment, the problem may be a loose or broken bridge cable, or a problem in the translator unit on that LAN segment.

Network status details can be requested and displayed on a panel. These details show the most recent soft error, beaconing, continuous carrier, and no carrier conditions for each LAN segment. And they show the portion of the network most likely to contain the error (the *fault domain*).

Bridge Program Status
The messages near the bottom of the screen and the information that can be displayed in the center of the panel include details about:

- The functioning of the Bridge Program and the bridge adapters
- The configuration parameter settings currently being used by the Bridge Program
- The traffic flowing through the bridge
- Links with network manager programs.

The bridge traffic information that can be displayed includes:

- The Path Trace Log

  Any frame passed across the bridge that has the system path trace request bit set on will cause an entry to be logged in the Path Trace Log. Entries can be displayed and cleared using the Bridge Program Path Trace panel.

- The performance counters and statistics

  The performance counters and statistics provide information about frames that are forwarded and not forwarded through the bridge.

  See "Bridge Performance Analysis" on page 13-6 for a description of the meaning and use of the Bridge Program performance information.

The IBM 8209 LAN Bridge

The IBM 8209 LAN Bridge (IBM 8209) allows devices on an IBM Token-Ring Network segment to communicate with devices on one of the following LAN segments:

- An Ethernet Version 2 or IEEE 802.3 LAN segment.

  Note: The IBM 8209 supports both the Ethernet Version 2 and IEEE 802.3 implementations of CSMA/CD protocols. IEEE 802.3 is based on and can coexist in a LAN with Ethernet Version 2. Ethernet Version 1 cannot coexist with either Ethernet Version 2 or with IEEE 802.3 and is not supported by the IBM 8209.

- Another IBM Token-Ring Network segment.

For two LAN segments that use different transmission and access protocols, the IBM 8209 performs the required access protocol conversion and data (frame) format conversion.

The appearance of the IBM 8209 to the devices on the connected LAN segments depends on the type of network and protocol being used.

- To a device on an IBM Token-Ring Network segment, the IBM 8209 appears as a source-routing bridge to another IBM Token-Ring Network segment.
- The IBM 8209 is functionally transparent to the stations on an Ethernet or IEEE 802.3 LAN segment.

An IBM Token-Ring Network connector and support are built into the IBM 8209 base unit. You install either an Ethernet/IEEE 802.3 attachment module or a token-ring attachment module in the IBM 8209 base unit to provide the other LAN connection and support.

The IBM 8209 base connection and token-ring attachment module connection both support either a 4- or 16-Mbps IBM Token-Ring Network segment. The Ethernet attachment module supports connection of a 10-Mbps Ethernet Version 2 or IEEE 802.3 LAN segment.

Though the IBM 8209 can operate in many LAN environments without changing the bridge configuration parameter values, the IBM 8209 provides the capability to modify configuration parameter values to meet the needs of your network.

- You can change basic configuration parameter values by setting switches on the attachment module.
- You can change advanced configuration parameter values by using the IBM 8209 Utility Program or a network management program such as the IBM LAN Network Manager.

The IBM 8209 supports the use of the following protocols and interfaces:

- SNA, NETBIOS, and TCP/IP by stations on both the IEEE 802.3 networks and Ethernet networks
- Any higher level protocols that are supported by the stations on an IBM Token-Ring Network, including SNA and NETBIOS.

The IBM 8209 does not limit the use of any protocols that are compatible for communication and that adhere to the industrial protocol standards for token-ring and Ethernet LANs.

The IBM 8209 also provides *filtering*, which is the process of providing isolation between the LANs so that unnecessary data transfer activity does not intrude into one network environment from the other network environment. This isolation process allows communication between devices on two active LAN segments without significantly increasing the contention problems on either LAN segment.

IBM 8209 Installation and Configuration

IBM 8209 installation consists of setting up the base, inserting an attachment module in the back of the base, and connecting LAN and power cables.

During IBM 8209 installation or as network needs change, you can specify values or use the default values for:

- Basic configuration parameters, set by the switches on the attachment module

  The *Attachment Module Guide* for each module describes how to set the switches and how to determine the settings to use.

- Advanced configuration parameters, specified by using the IBM 8209 Utility Program or a network management program such as the IBM LAN Network Manager.

  The *IBM 8209 LAN Bridge Customer Information* contains IBM 8209 installation instructions and planning information for installation and configuration.

  The *Attachment Module Guide* for each module contains descriptions of the advanced parameters and a Bridge Planning Chart on which you can record basic and advanced parameter values as you determine them.

The person installing each IBM 8209 for your network will ask you or the network planner to provide a completed copy of the Bridge Planning Chart indicating any changes to the bridge configuration parameter values.

All configuration parameter values can be set and changed by using the Utility Program. Some parameter values can be changed using the IBM LAN Manager or the IBM LAN Network Manager.

Filtering

You can use filters with the IBM 8209 to limit the traffic that can cross a bridge. Filters can limit the traffic that can cross a bridge in a number of ways, including:

- Restricting the number of pairs of users exchanging information across the bridge at one time
- Forwarding or filtering frames from specific adapter addresses
- Forwarding or filtering frames with certain values in specific fields.

Use of filters with the IBM 8209 is optional. You may choose to use filters to limit the traffic crossing some or all IBM 8209s in the network, depending on what traffic needs to cross each bridge.

The filters available with the IBM 8209 are described in the sections that follow about each type of attachment module.

The IBM 8209 with the Ethernet/IEEE 802.3 Attachment Module

The IBM 8209 LAN Bridge Attachment Module for Ethernet Version 2 and IEEE 802.3 LANs (Ethernet attachment module) allows devices on an Ethernet or IEEE 802.3 LAN segment to communicate with devices on an IBM Token-Ring Network segment through an IBM 8209 LAN Bridge.

The IBM 8209 with an Ethernet attachment module provides:

- Spanning-tree protocol on the Ethernet or IEEE 802.3 LAN to allow only a single path for frames between any two stations in the network
- Transfer of frames between stations on an IBM Token-Ring Network segment and stations on an Ethernet Version 2 or IEEE 802.3 LAN segment, with appropriate support and conversion for different access protocols and frame formats
  - Conversion between different access protocols (token-passing ring and CSMA/CD)
  - Frame format conversion.
- Frame filtering.

Differences between Ethernet Version 2 and IEEE 802.3 LANs exist at protocol levels, requiring the IBM 8209 to support two different modes of frame format conversion between the IBM Token-Ring Network segment and an Ethernet/IEEE 802.3 LAN segment. As described in the Ethernet/IEEE 802.3 *Attachment Module Guide*, the IBM 8209 provides:

- Mode 1 — frame format conversion between Ethernet Version 2 and IBM Token-Ring Network frame formats.

  In mode 1, the IBM 8209 provides:

  - Subnetwork access protocol (SNAP) header processing to support the TCP/IP protocol
  - RISC technology protocol header processing for SNA, NETBIOS, and other LLC-based protocols.
- Mode 2 — frame format conversion between IEEE 802.3 and IBM Token-Ring Network frame formats.

  In mode 2, the IBM 8209 transparently supports the transfer of LLC data for LLC-based protocols such as SNA and NETBIOS.

IBM 8209 Address Databases

The IBM 8209 maintains a block of non-volatile storage that acts as two separate databases:

- A token-ring database
- An Ethernet database.

In the Ethernet database, the IBM 8209 records the adapter address of each station and the format (either Ethernet Version 2 or IEEE 802.3) in which frames are originated from each station on the Ethernet LAN.

When IBM 8209 automatic mode selection is enabled, the IBM 8209 can check the Ethernet database for the frame format of the Ethernet station to which a token-ring originated frame is sent. The IBM 8209 can then convert the token-ring frame format to the correct Ethernet format (Ethernet Version 2 or IEEE 802.3).

The IBM 8209 determines the mode of frame format conversion for the token-ring frames by checking the database for the frame format of the Ethernet station. If there is no entry in the database for an Ethernet station, the IBM 8209 uses the frame format conversion mode selected by the attachment module mode selection switch.

Ethernet Attachment Module Basic Configuration

You can set five switches on the Ethernet attachment module to specify values for the following basic configuration parameters:

- Automatic Mode Selection (Switch 1)

  This switch setting enables or disables automatic mode selection.

  When automatic mode selection is enabled, the IBM 8209 dynamically determines whether to convert a frame from the IBM Token-Ring Network to Ethernet Version 2 or IEEE 802.3 format. If the IBM 8209 cannot determine the correct format, it uses the format specified by the Mode Selection switch (switch 2).

  When automatic mode selection disabled, the IBM 8209 converts IBM Token-Ring Network frames to the format specified by the Mode Selection switch.

- Mode Selection (Switch 2)

  This switch setting selects Mode 1 or Mode 2 to specify whether frames from the IBM Token-Ring Network are converted to Ethernet Version 2 (Mode 1) or IEEE 802.3 format (Mode 2) when:

  - Automatic selection is disabled
  - Automatic mode selection cannot determine the correct format.

- Bridge Number and Ethernet LAN Segment Number (Switches 3 and 4)

  Switches 3 and 4 together set the IBM 8209 bridge number and the Ethernet LAN segment number to one of the four combinations shown in Table 15-14 on page 15-93.

Table 15-14. Switches 3 and 4

Switch 3	Switch 4	Bridge Number	Ethernet LAN Segment Number
●	●	0	X'FF0'
●	▲	1	X'FF1'
▲	●	2	X'FF2'
▲	▲	3	X'FF3'

Note:

The LAN segment number for the IBM Token-Ring Network segment defaults to 1 and can be changed by using the Utility Program or a network management program such as the IBM LAN Network Manager.

The Ethernet LAN segment number and the bridge number can also be changed by the Utility Program or a network management program.

- IBM Token-Ring Network Data Transfer Rate (Switch 5)

  This switch specifies whether the IBM Token-Ring Network segment connected to the IBM 8209 base transfers data at 4 or 16 Mbps.

  Switch 5 can also be used to reset the advanced configuration parameter values to the factory defaults. The general steps to reset the configuration (also called a *logic board reset*) are the following:

  1. Turn the IBM 8209 power off.
  2. Remove the attachment module from the IBM 8209.
  3. Change the setting of switch 5 to the opposite of its current setting.
  4. Install the attachment module in the IBM 8209.
  5. Turn the IBM 8209 power on and wait at least 40 seconds.
  6. Turn the IBM 8209 power off, remove the module, set the switch to the desired setting for normal operation, reinstall the module, and turn the IBM 8209 power on.

  Once the switches are set, basic configuration is complete and the attachment module can be installed in the IBM 8209.

Advanced Configuration

If the preset default values of the IBM 8209 advanced configuration parameters do not meet the needs of your network, you can use the IBM 8209 Utility Program (for all of the parameters) or a network management program (for some of the parameters) to change the values.

The Ethernet *Attachment Module Guide* contains detailed descriptions of the following advanced configuration parameters:

- Bridge number

  The bridge number uniquely identifies a bridge in frame routing information when frames are forwarded through a bridge.

- Token-Ring LAN segment number

  This parameter specifies the LAN segment number of the IBM Token-Ring Network segment connected to the base connector. This value overrides the default LAN segment number of 1.

- Locally administered address

  You can use this parameter to assign a particular value for the token-ring adapter address, to override the universally administered address.

  If you assign a locally administered address during bridge configuration, you must redefine the adapter address in the Bridge Definition to match the assigned address.

- Early Token Release

  This parameter enables or disables Early Token Release for the IBM 8209 token-ring connection.

  Early Token Release enables a token-ring adapter to gain access to a token more frequently. The adapter can release a new token immediately after transmitting a frame, instead of waiting for the copied frame to return from the receiver.

Early Token Release is disabled for 4-Mbps rings and is usually disabled for 16-Mbps rings if all adapters on the ring are not using Early Token Release.

- Ethernet LAN segment number

  The value of this parameter overrides the Ethernet LAN segment number set by the attachment module configuration switches.

  This value must be different from the LAN segment number specified for the token-ring segment.

- Locally administered address

  You can use this parameter to assign a particular value for the Ethernet adapter address, to override the universally administered address.

  If you assign a locally administered address during bridge configuration, you must redefine the adapter address in the Bridge Definition to match the assigned address.

- Hop count limit

  This value specifies the number of consecutive bridges through which a broadcast frame can travel, including the current bridge.

  If the number of bridges a frame has passed through is equal to or greater than this hop count limit, this bridge will not transmit the frame further.

- Parameter server

  This parameter specifies whether the bridge parameter server functional address is enabled or disabled for the token-ring segment.

  When the parameter server is enabled, the bridge provides:

  - The LAN segment number to an adapter when the adapter is attaching to the LAN segment
  - Notification to one or more network management programs that a new adapter has attached to the LAN segment.

- Error monitor

  This parameter specifies whether the bridge error monitor functional address is enabled or disabled for the token-ring segment.

  When the error monitor is enabled, it:

  - Collects and analyzes soft error reports on the token-ring segment
  - Reports critical situations and probable causes to network management programs.

- Configuration report server

  This parameter specifies whether the bridge configuration report server functional address is enabled or disabled for the token-ring segment.

  When the configuration report server is enabled, it notifies network management programs when the current active network configuration of the token-ring segment changes (when a NAUN or active monitor changes).

- Automatic mode selection

  This parameter value enables or disables automatic mode selection and overrides the attachment module basic configuration switch setting for automatic mode selection.

- Mode Priority

  This parameter value determines whether the IBM 8209 expects frames on the Ethernet LAN segment to be in Ethernet Version 2 format (Mode 1) or in IEEE 802.3 format (Mode 2). This value overrides the setting of the attachment module basic configuration switch for mode selection.

- Forward LLC Traffic (Mode 1)

  This parameter determines whether the IBM 8209 is to enable or disable the forwarding of frames for IEEE 802.3 LLC-based protocols from the IBM Token-Ring Network segment to the Ethernet LAN when the IBM 8209 is forwarding mode 1 traffic.

  When this function is enabled, the LLC-based protocol frames that are forwarded must contain a destination service access point (DSAP) that is included in the list specified in the Enabled SAPs for LLC Traffic parameter.

- Enabled SAPs for LLC Traffic

  This parameter allows you to specify up to 10 DSAPs for LLC-based protocol frames that will be forwarded when forwarding of LLC traffic is enabled in mode 1.

  If you do not specify values for this parameter, the default-enabled SAPs are hex 00, 04, 08, F0, F4, and FC (which support SNA and NETBIOS frames).

- TCP/IP Address Conversion

  This parameter indicates whether the IBM 8209 is to perform bit-order address inversion on the addresses within the I-Field of TCP/IP address resolution protocol/reverse address resolution protocol (ARP/RARP) and ARP/RARP response frames. This conversion allows communication between versions of these protocols that are not otherwise compatible.

- Dual Mode Multicast Conversion

  This parameter indicates whether the IBM 8209 is to transmit two multicast frames (one in Ethernet Version 2 format and one in IEEE 802.3 format) for each frame with a group or broadcast address that is forwarded from the IBM Token-Ring Network when automatic mode is enabled.

- Use General Broadcast Frames

  This parameter indicates whether the IBM 8209 is to forward a frame to the IBM Token-Ring Network segment as an all-routes broadcast (enabled) frame or a single-route broadcast frame (disabled) when the destination address is not found in the token-ring database.

- Broadcast Address Conversion

  When this function is enabled, the IBM 8209 converts the IBM Token-Ring Network all-stations broadcast address of X'C000 FFFF FFFF' in a frame to the Ethernet all-stations broadcast address of X'FFFF FFFF FFFF'. The conversion is from token-ring to Ethernet only.

  When this function is disabled, the IBM 8209 in its normal address conversion converts the IBM Token-Ring Network all-stations broadcast address of X'C000 FFFF FFFF' in a frame to the Ethernet address of X'0300 FFFF FFFF' (which is not known as an all-stations broadcast address). If you want the IBM 8209 to convert the Ethernet addresses X'FFFF FFFF FFFF' or X'0300 FFFF FFFF' to the token-ring all-stations address, you must specify the Ethernet address and the token-ring address as a mapped address pair in the mapped addresses parameter.

- Criteria Range Filter Offset

  This parameter specifies the byte offset into the MAC data (information) field of the 2 bytes of information that are compared with the filter range values. The beginning of the information field varies with the frame format:

  - The Ethernet frame information field offset of zero is at the beginning of the TYPE field.
  - The information field offset of zero for token-ring and IEEE 820.3 frames is at the beginning of the DSAP field.

  See the frame formats in the *Attachment Module Guide*.

  You can specify a separate filter offset and two pairs of high and low ranges for each IBM 8209 LAN connection. If the information at the offset into the information field is not within a pair of range values or equal to a high or low range value, the frame is discarded.

- Source and Destination Address Low and High Values

  These parameters specify the hexadecimal 12-digit low and high source address and low and high destination address for the address range filter. There is a separate address range filter for each IBM 8209 LAN connection.

  Frames with source or destination addresses within the specified values are filtered (discarded) by the IBM 8209.

- Spanning-Tree Parameters

  The spanning-tree parameters are used in an Ethernet or IEEE 802.3 network to maintain one and only one path between any two LAN segments in the network. The parameter values are used to:

  - Determine which one of two or more parallel bridges between two LAN segments is active at any one time
  - Detect when a bridge has left or entered the network, and readjust active bridges accordingly
  - Determine the relative "length" of the path in the network between two LAN segments (path cost).

  The spanning-tree parameters that can be changed by using the Utility Program are shown in Table 15-15.

Table 15-15 (Page 1 of 2). Spanning-Tree Parameters

Parameter Description	**Default Value**	**Allowed Range**
Bridge Maximum Age	20	6-40 seconds
Bridge Hello Time	2	1-10 seconds
Bridge Forward Delay	15	4-30 seconds
Bridge Priority	32768	1-65535
Port Path Cost	250 (4 Mbps) 63 (16 Mbps) 100 (Ethernet)	0-65535

Table 15-15 (Page 2 of 2). Spanning-Tree Parameters		
Parameter Description	**Default Value**	**Allowed Range**
Port Priority	128	0-255

- Aging Time

  This parameter defines in seconds the amount of time that a dynamic entry in the IBM 8209 address database is retained after last use.

- Maximum Transit Time

  This parameter defines in seconds the maximum time that can elapse between the reception and transmission of a forwarded frame. The IBM 8209 discards a frame that has been held at the IBM 8209 for this period of time, unless the frame has already been queued for transmission.

- Link Passwords

  The bridge uses these passwords to determine whether the Utility Program, or a network management program such as the IBM LAN Network Manager, is authorized to establish a communication link with the bridge.

  Note: The Utility Program acts only as a controlling network management program (not an observing program) and therefore can use only link 0.

  Before a link can be established with this IBM 8209, the program operator must specify a reporting link password in the Utility Program or network management program system definition. The reporting link password must be the link password defined in this bridge advanced configuration for the correct link number.

- Ethernet Static Address Entries

  Each of these parameter values is the station (adapter) address of an Ethernet station that sends frames over the IBM 8209. The IBM 8209 determines the frame format used by each station and records it in the IBM 8209 address database with the station address.

  You can add these entries manually or from a file to the Ethernet address database; you can save them in a file before deleting and redefining the IBM 8209 configuration. They cannot be deleted when the database entry aging time expires. You must delete them manually or do a logic board reset to remove them from the database.

- Mapped Addresses

  These entries specify a pair of addresses, one Ethernet and one token-ring. The IBM 8209 converts an Ethernet frame's destination address to the corresponding token-ring address if the destination address is found in these entries.

  The addresses are entered in their originating format (token-ring addresses in IEEE 802.5 format and Ethernet addresses in Ethernet/IEEE 802.3 format).

IBM 8209 Utility Program

The IBM 8209 Utility Program can be used with PC DOS Version 3.3 or later, or with OS/2 EE Version 1.1 or later.

The Utility Program runs in a personal computer containing a network adapter that is connected to a LAN segment in the network with the IBM 8209. The operating system in the personal computer or a separately installed program must provide device driver support for the network adapter.

DOS device drivers can be provided in two ways:

1. Install the LAN Support Program in the Utility Program computer after DOS is installed and before the Utility Program is installed.
2. Install the Utility Program in the same computer with the IBM LAN Manager Version 1.0, and use the device drivers that are included as part of the IBM LAN Manager.

In the DOS environment, the Utility Program and the IBM LAN Manager Version 1.0 can be installed in the same personal computer, but only one of the two programs can be running at a time. (The IBM LAN Manager Version 2.0 and the IBM LAN Network Manager programs must run with OS/2 EE.)

OS/2 EE adapter support is included with the OS/2 EE operating system and does not need to be installed as part of a separate program.

If the Utility Program uses the same computer as an IBM LAN Manager or IBM LAN Network Manager program, follow the instructions in the OS/2 EE publications for including in the CONFIG.SYS file the device drivers needed for IBM Token-Ring Network adapter support.

Note: If you are using an Ethernet adapter, you need to include in the installation the required Ethernet adapter support.

Once an IBM 8209 is defined to the Utility Program, you can establish a link with the bridge. The link with a bridge is required whenever you need to use the Utility Program to communicate with a bridge, but is not required for normal bridge frame forwarding. You must establish a link between the Utility Program and the bridge before you can do advanced configuration for the bridge.

In addition to the advanced configuration function, the Utility Program also provides:

- The Bridge Profile function, which displays
  - Ethernet counters for collisions and invalid frame errors
  - Current values of advanced configuration parameters, static address entries, and mapped address entries
  - Current and maximum number of static address database entries and of mapped address database entries.
- Bridge Definition and System Definition functions to define the bridge to the Utility Program
- Establishment and termination of the link between the Utility Program and an IBM 8209 (the Link and Unlink functions).

The IBM 8209 with the Token-Ring Attachment Module

The IBM 8209 LAN Bridge Attachment Module for the IBM Token-Ring Network (token-ring attachment module) allows devices on one IBM Token-Ring Network segment to communicate with devices on another IBM Token-Ring Network segment through an IBM 8209 LAN Bridge. The IBM 8209 with a token-ring attachment module provides:

- Single-route broadcast protocol (an implementation of spanning-tree protocol) to allow only a single path between any two token-ring segments in the network for single-route broadcast messages
- Transfer of frames between two IBM Token-Ring Network segments
- Filtering of frames to isolate each LAN segment from unnecessary LAN activity from the other LAN segment.

To a device on either LAN segment, the IBM 8209 appears as a source-routing bridge to another LAN segment. The IBM 8209 supports either a 4- or 16-Mbps LAN segment on each connection.

Token-Ring Attachment Module Basic Configuration

The five switches on the token-ring attachment module are used to indicate to the IBM 8209 the values of the following basic configuration parameters:

The attachment module is shipped with the preset configuration shown in Table 15-16.

Table 15-16. Preset Configuration Switch Settings

Switch Number	**Switch Function**	**Preset Default**
1 and 2	Initial Base LAN Segment Number	● ● (1)
3	Initial Bridge Number	● (1)
4	Token-Ring Network Data Transfer Rate – Module	● (4 Mbps)
5	Token-Ring Network Data Transfer Rate – Base	● (4 Mbps)

- Initial LAN Segment Number (Switches 1 and 2)

  The settings of switches 1 and 2 determine the initial LAN segment number for the token-ring segment connected to the IBM 8209 base token-ring connector.

  The initial LAN segment number for the token-ring segment connected to the attachment module is one greater than the base LAN segment number set in switches 1 and 2.

  The switches are preset to a LAN segment number of 1 (the module LAN segment number is then 2). Table 15-17 shows you how to set the switches to one of four combinations for the base LAN segment number.

Table 15-17. Switches 1 and 2			
Switch 1	**Switch 2**	**Base LAN Segment Number**	**Module LAN Segment Number**
●	●	1	2
▲	●	2	3
●	▲	3	4
▲	▲	4	5

You can use the Utility Program or a network management program to change one or both LAN segment numbers.

- Initial Bridge Number (Switch 3)

  The setting of switch 3 determines the bridge number for this IBM 8209.

Table 15-18. Switch 3	
Switch 3	**Bridge Number**
●	1
▲	2

  You can use the Utility Program or a network management program to change the bridge number to a value other than 1 or 2.

- IBM Token-Ring Network Data Transfer Rate — Module (Switch 4)

  Switch 4 indicates to the IBM 8209 the data transfer rate (4 or 16 Mbps) being used by the LAN segment connected to the attachment module connector.

- IBM Token-Ring Network Data Transfer Rate — Base (Switch 5)

  Switch 5 indicates to the IBM 8209 the data transfer rate (4 or 16 Mbps) being used by the LAN segment connected to the base IBM 8209 connector.

  Note: The data transfer rates indicated by switches 4 and 5 can be the same or different.

  Switch 5 can also be used to reset the advanced configuration parameter values back to the original factory defaults. The general steps to reset the configuration (also called a *logic board reset*) are the following:

  1. Turn the IBM 8209 power off.
  2. Remove the attachment module from the IBM 8209.
  3. Change the setting of switch 5 to the opposite of its current setting.
  4. Install the attachment module in the IBM 8209.
  5. Turn the IBM 8209 power on and wait at least 40 seconds.
  6. Turn the IBM 8209 power off, remove the module, set the switch to the desired setting for normal operation, reinstall the module, and turn the IBM 8209 power on.

Once the switches are set, basic configuration is complete and the attachment module can be installed in the IBM 8209.

Advanced Configuration

If the preset default values of the IBM 8209 advanced configuration parameters do not meet the needs of your network, you can use the IBM 8209 Utility Program (for all of the parameters) or a network management program (for some of the parameters) to change the values.

The token-ring *Attachment Module Guide* contains detailed descriptions of the following advanced configuration parameters:

- Bridge number

  The bridge number uniquely identifies a bridge in frame routing information when frames are forwarded through a bridge.

- Base LAN segment number

  This parameter specifies the LAN segment number of the IBM Token-Ring Network segment connected to the base connector. This value must be different from the LAN segment number assigned to the segment connected to the attachment module.

- Locally administered address

  You can use this parameter to assign a particular value for a token-ring adapter address, to override the universally administered address.

  If you assign a locally administered address during bridge configuration, you must redefine the adapter address in the Bridge Definition to match the assigned address.

- Module LAN segment number

  This parameter specifies the LAN segment number of the IBM Token-Ring Network segment connected to the module connector. This value must be different from the LAN segment number assigned to the segment connected to the base connector.

- Single-Route Broadcast Mode

  This value allows you to choose whether to:

  - Set the single-route broadcast parameter manually for this bridge (and for each bridge in the network)—manual mode.
  - Let the bridges themselves automatically determine and set the single-route broadcast parameter values for each bridge in the network—automatic mode.

- Path Trace

  When path trace is enabled and a frame that has the system path trace bit set on passes through the bridge, a notification is sent to any network management programs that have a communication link established with the bridge.

- Single-Route Broadcast

  You use this parameter value to specify if single-route broadcast frames are to be passed from one LAN segment to the other through the bridge computer or discarded when single-route broadcast manual mode is selected.

- Hop Count Limit

  This parameter specifies the number of consecutive bridges (maximum value is 7) through which a broadcast frame can travel, including the current bridge.

  If the hop count in the frame is equal to or greater than the hop count value for the current bridge, the bridge discards the frame.

  Note: Hop count does not apply to non-broadcast frames or to single-route broadcast frames.

- Early Token Release

  Early Token Release enables a token-ring adapter on a 16-Mbps ring to gain access to a token more frequently. The adapter can release a new token immediately after transmitting a frame, instead of waiting for the copied frame to return from the receiver.

  Early Token Release is disabled for 4-Mbps rings, and is usually disabled for 16-Mbps rings if all adapters on the ring are not using Early Token Release.

- Parameter server

  This parameter specifies whether the bridge parameter server functional address is enabled or disabled for the token-ring segment.

  When the parameter server is enabled, the bridge provides:

  - The LAN segment number to an adapter when the adapter is attaching to the LAN segment
  - Notification to one or more network management programs that a new adapter has attached to the LAN segment.

- Error monitor

  This parameter specifies whether the bridge error monitor functional address is enabled or disabled for the token-ring segment.

  When the error monitor is enabled, it:

  - Collects and analyzes soft error reports on the token-ring segment
  - Reports critical situations and probable causes to network management programs.

- Configuration report server

  This parameter specifies whether the bridge configuration report server functional address is enabled or disabled for the token-ring segment.

  When the configuration report server is enabled, it notifies network management programs when the current active network configuration of the token-ring segment changes (when a NAUN or active monitor changes).

- Filter program status

  This parameter indicates whether a filter program that is loaded in the IBM 8209 is enabled or disabled when the IBM 8209 is running.

  To stop a loaded filter program from running when the IBM 8209 is running, set this value to 0 (disabled).

- Criteria Range Filter Offset

  This parameter specifies the byte offset into the MAC data (information) field of the 2 bytes of information that are compared with the filter range values.

The information field offset of zero for token-ring frames is at the beginning of the DSAP field. See the frame formats in the *Attachment Module Guide*.

You can specify a separate filter offset and two pairs of high and low ranges for each IBM 8209 LAN connection. If the information at the offset into the information field is not within a pair of range values or equal to a high or low range value, the frame is discarded.

- Source and Destination Address Low and High Values

  These parameters specify the hexadecimal 12-digit low and high source address and the low and high destination address for the address range filter. There is a separate address range filter for each IBM 8209 LAN connection.

  Frames with source or destination addresses within the specified values are filtered (discarded) by the IBM 8209.

- Spanning-Tree parameters

  The spanning-tree parameters are used by the automatic single-route broadcast function to maintain one and only one path for single-route broadcast frames between any two LAN segments in the network. The parameter values are used to:

  – Determine which one of two or more parallel bridges between two LAN segments is able to forward single-route broadcast frames at any one time
  – Detect when a bridge has left or entered the network and readjust single-route broadcast parameter values for active bridges accordingly
  – Determine the relative "length" of a path in the network between two LAN segments (path cost).

  The spanning-tree parameters that can be changed by using the Utility Program are shown in Table 15-19 on page 15-104.

Table 15-19. Spanning-Tree Parameters

Parameter Description	Default Value	Allowed Range
Bridge Priority	32768	1-65535
Port Path Cost	250 (4 Mbps) 63 (16 Mbps)	0-65535
Port Priority	128	0-255

- Link Passwords

  The bridge uses these passwords to determine whether the Utility Program, or a network management program such as the IBM LAN Network Manager, is authorized to establish a communication link with the bridge. The Utility Program acts only as a controlling network management program (not an observing program).

  Before a link can be established with this IBM 8209, the program operator must specify a reporting link password in the Utility Program or network management program system definition. The reporting link password must be the link password defined in this bridge advanced configuration for the correct link number.

- Load Filter Program parameters

  These parameters are used to cause the IBM 8209 to load and use a filter program (when the Filter Program Status is 1 - enabled).

  - Drive ID

    This parameter specifies the drive letter of the disk drive where the filter program is stored. A value of 0 indicates the default drive.

  - Pathname

    This parameter specifies the full path and name of the filter program. If the drive where the filter program resides is specified in the pathname, it will override the drive specified in *drive ID*.

Filter Programs

In addition to the criteria range and address range filters specified in the bridge configuration file, the IBM 8209 with the token-ring attachment module supports the loading and running of a single filter program when the IBM 8209 is running.

Two filter programs are provided with the IBM 8209 Utility Program. You can also write your own filter programs to run in the IBM 8209. The token-ring *Attachment Module Guide* explains how to write a filter program and prepare the executable module for use with the IBM 8209.

The two filter programs provided with the Utility Program are:

- The link limiting filter program (FILTER1.EXE), which limits the number of unique source and destination address pairs that can exchange information at one time through the bridge.
- The NETBIOS filter program (FILTER2.EXE), which helps limit the proliferation of NETBIOS frames crossing from one LAN segment to the other.

The UPDATE command, executed from the FILTER.BAT (DOS) or FILTER.CMD (OS/2) file, is used to pass parameters to a filter program.

The steps to load and use a single filter program in the IBM 8209 are:

1. Start the IBM 8209 Utility Program and establish a link to the IBM 8209 bridge.
2. Make sure that the Filter Program Status field in the bridge configuration parameters is set to 1 (to enable filtering)
3. Specify in the fields of the Load Filter Program configuration parameter the full pathname of the program and the disk drive in which it resides.
4. Press Enter. The "Operation completed successfully" message appears and the filter program is loaded and running in the IBM 8209.

The Link Limiting Filter Program

The link limiting filter program (FILTER1.EXE) can help reduce the frame traffic through the bridge by limiting the number of pairs of unique source and destination addresses that can exchange information at one time through the bridge.

The UPDATE command filter parameters for this filter program are LINKS and TIME.

LINKS: The number (1 - 256) of unique source and destination address pairs that will be allowed to send frames through the bridge at one time.

TIME: The time interval (1 - 3600 seconds) in which each session must contain activity between the source and destination address pair to guarantee that the session remains active.

The NETBIOS Filter Program

The NETBIOS filter program (FILTER2.EXE) helps limit the proliferation of NETBIOS frames crossing a bridge from one LAN segment to the other.

UPDATE command parameter values for this filter program are NAME, ADP, and ACTION.

ADP: This optional parameter specifies the IBM 8209 port (base or module LAN connection) that will receive the frames to be checked by the filter program.

If this parameter is not specified, both ports will be checked.

NAME: The NETBIOS filter program maintains a table of NETBIOS names, which you specify using the NAME parameter on the UPDATE command.

In the NAME parameter, you can specify:

- A single NETBIOS name, or a series of up to 50 names
- A series of names with a common prefix, by specifying the prefix immediately followed by an asterisk (*)
- A series of names that have some characters in common and other characters that differ. Specify the letters that are in common; specify a question mark (?) for each single character that differs in the series of names.

The filter program compares the names in the table with the source name field (for ADD_GROUP_NAME_QUERY and ADD_NAME_QUERY frames) or the destination name field (for NAME_QUERY and DATAGRAM frames) in the NETBIOS UI-frame header. The filter program takes the action defined in the ACTION parameter.

All other NETBIOS frame types are forwarded, unless you specify to filter (discard) all NETBIOS frames or all DATAGRAM_BROADCAST frames.

ACTION: The ACTION parameter of the UPDATE command specifies whether the filter program is to:

- Forward all frames for which there is a match (FORWARD)
- Filter (DISCARD) all frames for which there is a match
- Filter all NETBIOS frames (DISCARDALL)
- Filter all DATAGRAM_BROADCAST frames (DISCARDDB).

The destination NETBIOS name in the frame will be compared to the name(s) in the names table. If a match is found, the frame will be discarded (DISCARD) or forwarded (FORWARD). If a match is NOT found, the opposite action will be taken. Also, all DATAGRAM_BROADCAST frames can be discarded (DISCARDDB) or ALL NETBIOS frames can be discarded (DISCARDALL).

IBM 8209 Utility Program

The IBM 8209 Utility Program can be used with PC DOS Version 3.3 or later, or with OS/2 EE Version 1.1 or later.

The Utility Program runs in a personal computer containing a network adapter that is connected to a LAN segment in the network with the IBM 8209. The operating system in the personal computer or a separately installed program must provide device driver support for the network adapter.

DOS device drivers can be provided in two ways:

1. Install the LAN Support Program in the Utility Program computer after DOS is installed and before the Utility Program is installed.
2. Install the Utility Program in the same computer with the IBM LAN Manager Version 1.0, and use the device drivers that are included as part of the IBM LAN Manager.

In the DOS environment, the Utility Program and the IBM LAN Manager Version 1.0 can be installed in the same personal computer, but only one of the two programs can be running at a time. (The IBM LAN Manager Version 2.0 and the IBM LAN Network Manager programs must run with OS/2 EE.)

OS/2 EE adapter support is included with the OS/2 EE operating system and does not need to be installed as part of a separate program. If the Utility Program uses the same computer as an IBM LAN Manager or IBM LAN Network Manager program, follow the instructions in the OS/2 EE publications for including in the CONFIG.SYS file the device drivers needed for IBM Token-Ring Network adapter support.

Once an IBM 8209 is defined to the Utility Program, you can establish a link with the bridge. The link with a bridge is required whenever you need to use the Utility Program to communicate with a bridge but is not required for normal bridge frame forwarding. You must establish a link between the Utility Program and the bridge before you can do advanced configuration for the bridge.

In addition to the advanced configuration function, the Utility Program also provides:

- The Bridge Profile function, which displays the current values of the advanced configuration parameters
- Bridge Definition and System Definition functions to define the bridge to the Utility Program
- Establishment and termination of the link between the Utility Program and an IBM 8209 (the Link and Unlink functions).

The IBM Token-Ring Network/PC Network Interconnect Program

The IBM Token-Ring Network/PC Network Interconnect Program allows users on an IBM Token-Ring Network and an IBM PC Network to communicate with each other using the NETBIOS interface.

An IBM Token-Ring Network PC Adapter and an IBM PC Network Adapter are used, with the Interconnect Program, in an IBM Personal Computer to connect the two networks.

DOS, the Adapter Support Interface supplied with each IBM Token-Ring Network PC Adapter, and the NETBIOS Program must be loaded before the Interconnect Program can be loaded and run.

You must assign a unique network name to each program (user) that will communicate across the Interconnect Program. The name assigned to a program must conform to the naming convention used by that program; for example:

- Some programs cannot use adapter addresses as network names.
- The allowed length of the name may differ among programs.
- A program may require or prohibit the use of certain characters (such as ASCII control characters, special symbols, or blanks).

The documentation packaged with the Interconnect Program and with each program that uses the Interconnect should explain network name restrictions and requirements.

Interconnect Program Configuration Parameters

The Interconnect Program provides a configuration program and panels that help you create a configurator file. You must specify appropriate configuration parameter values for:

- The unique network name assigned to each user on each network
- The size of the largest message to be sent across the Interconnect Program
- The message send time-out value
- The maximum number of sessions concurrently using the Interconnect Program
- The number of session buffers required in addition to those automatically provided by the Interconnect Program
- The session and datagram activity log (log buffer size, active/not active at Interconnect Program initialization, and stop/wrap when log buffer is full).

The *IBM Token-Ring Network/PC Network Interconnect User's Guide* explains the specification of Interconnect Program configuration parameters.

Interconnect Program Output

The Interconnect Program operator interface provides the ability to display:

- Error information for the Interconnect Program, network names, and adapters
- Current network names (allows adding and deleting names)
- The session and datagram activity log (can also be saved on disk or diskette)
- Session traffic status
- Remote and local adapter status.

Chapter 16. Gateways, Device Emulation, Servers, and Remote Connection Programs

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The following gateway, emulation, server, and remote connection programs operate with the indicated LANs:

Gateway, Emulation, Server, or Remote Program	IBM Token-Ring Network	IBM PC Network		Ethernet	MAP
		Broadband	Baseband		
Gateway Functions					
IBM PC 3270 Emulation Program	Yes	Yes	Yes		
IBM Personal Communications/3270 Emulation Program	Yes	Yes	Yes		
IBM Asynchronous Communications Server Program	Yes	Yes	Yes	No	No
LANACS	Yes	Yes	Yes	Yes	No
IBM APPC/PC Program	Yes	Yes	No		
IBM LAN to LAN Wide Area Network Program	Yes	Yes	Yes	Yes	No
IBM 3172 Interconnect Controller Program	Yes	No	No	Yes	No
Device Emulation					
IBM 3270 Workstation Program	Yes	No	No	Yes	No
Servers					
IBM PC LAN Program	Yes	Yes	Yes		
IBM OS/2 LAN Server Program	Yes	Yes	Yes		
LANACS	Yes	Yes	Yes	Yes	No
Remote Connections					
IBM Remote NETBIOS Access Facility Program	Yes	Yes	Yes	Yes	No

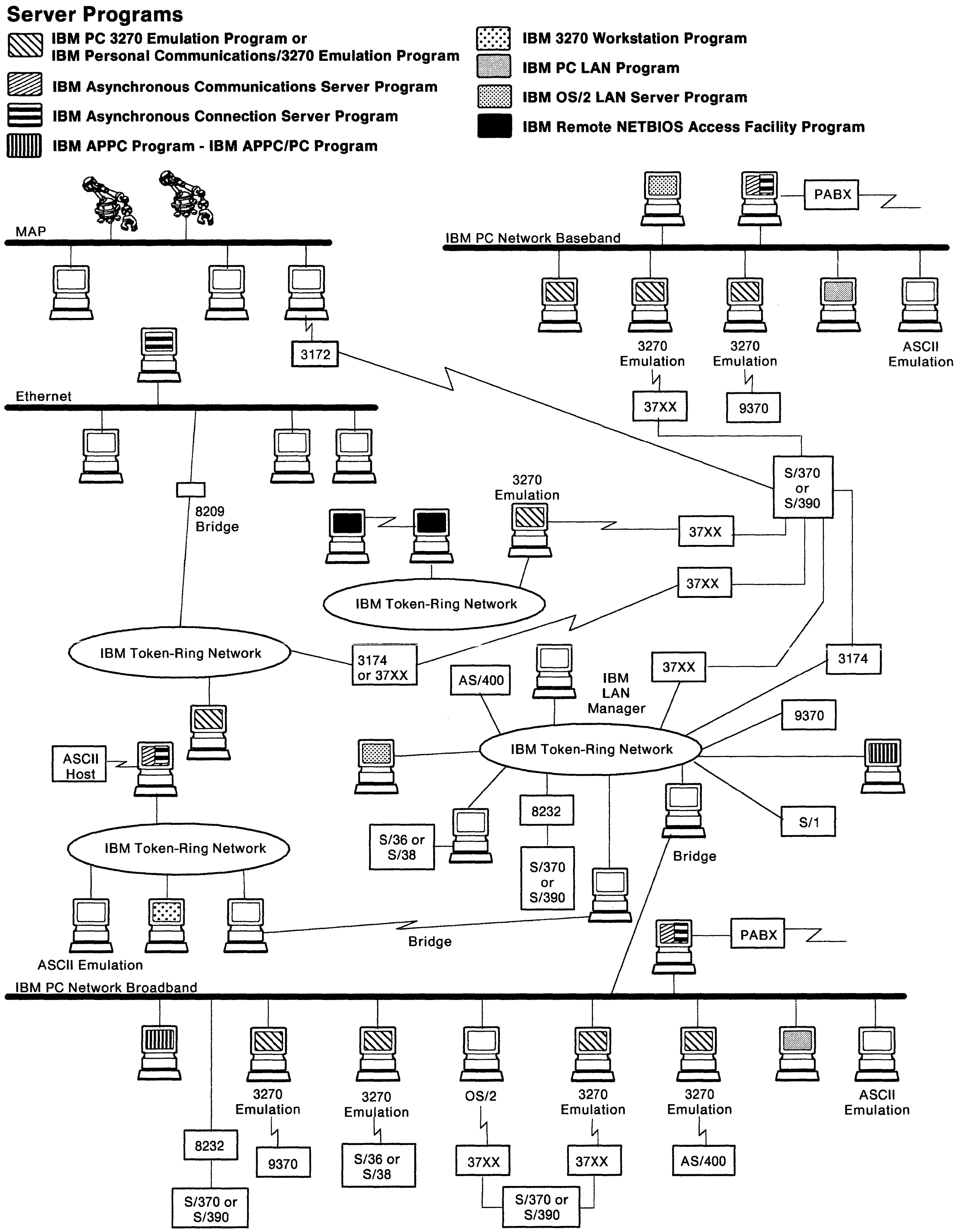

Figure 16-1. Gateway, Emulation, Server, and Remote Programs Used on a LAN

Overview

The table on page 16-2 identifies the specific gateway, emulation, server, and remote programs that operate with each of the indicated LANs. Figure 16-1 shows where gateway, emulation, server, and remote programs could be installed on the equipment connected to a LAN. The remainder of this chapter discusses each program in detail.

The IBM 3174 Establishment Controller

Chapter 12 discussed the IBM 3174 as a device connected to a LAN and participating in LAN communication. The IBM 3174 also serves as a gateway to a WAN. Used in this manner, the IBM 3174 provides support for:

- Local and Remote Gateways

  Supports host SNA communication for IBM 3174 Establishment Controller, personal computers, and System/36 or 38 computers.

  Local Gateway — Provides a direct connection to an IBM Token-Ring Network and a direct connection to an SNA host computer.

  Remote Gateway — Provides a direct connection to an IBM Token-Ring Network and a remote connection through an IBM 37XX to an SNA host.

- Downstream Physical Units (DSPUs)

  Provides a direct connection to an IBM Token-Ring Network to support attached terminals.

- Peer Communication

  Allows existing DOS-based devices to form a star-wired LAN segment that is bridged to an IBM Token-Ring Network through the IBM 3174 Establishment Controller.

IBM 3174 Establishment Controller Remote Gateway

The IBM 3174 Establishment Controller operated as a remote gateway has the following characteristics:

- Acts to an SNA host computer as a Physical Unit (PU) type 2 gateway for workstations and cluster control units
- Is connected through NCP to a host computer by a leased SDLC line. Switched SDLC, X.25, and X.21 lines are not supported
- Is defined to NCP as a PU on a leased SDLC line
- Supports Control Unit Terminals (CUTs) and Distributed Function Terminals (DFTs) connected directly to it
- Supports any combination of the following attached to an IBM Token-Ring Network
  - IBM PS/2 with OS/2 Extended Edition 1.1
  - IBM personal computer using:

    IBM PC 3270 Emulation Program
    IBM Personal Communications/3270 Emulation Program
    IBM APPC/PC Program (in PU type 2 mode)

- S/36 or 38 with the LAN Attachment Feature and using:

  IBM PC 3270 Emulation Program
  IBM APPC/PC Program (in PU type 2 mode)

- Another IBM 3174 as a DSPU
- IBM AS/400 computer.

IBM 3174 Establishment Controller Peer Communications

- 3174 Establishment Controller Peer Communications provides a means for intelligent devices to
  - Share resources, like files, data bases, and printers
  - Communicate peer to peer
  - Increase connectivity options
  - Retain host connectivity
- 3174 Peer Communications supports LAN sessions between
  - Devices attached to the same 3174 Peer Controller
  - A device attached to the 3174 Peer Controller and a device on the Token-Ring Network
  - Devices attached to two different 3174 Peer Controllers, if both controllers are attached to the same Token-Ring Network.

For more information see *IBM 3174 Establishment Controller Peer Communications Users Guide*.

Gateway Programs

Gateway Programs enable communication between dissimilar devices, dissimilar programs, or both. These programs translate protocols, formats, and other characteristics to achieve communication.

IBM PC 3270 Emulation Program

The IBM PC 3270 Emulation Program provides gateway services to a host computer for devices attached to an IBM Token-Ring Network or IBM PC Network.

This program enables an IBM PC or PS/2 computer to emulate an IBM 3174 Control Unit, a 3278/79 display, or a 3287 printer. The IBM PC 3270 Emulation Program:

- Requires the NETBIOS interface
- Supports direct attachment of an IBM Token-Ring Network to the IBM 3720, IBM 3725, or IBM 3745
- Supports direct attachment of an IBM Token-Ring Network to an IBM 3174 Control Unit
- Supports personal computers, configured as stand-alone workstations, network gateways, or network stations

  Stand-alone Looks to the host computer like an IBM 3174 supporting one display session or one printer session.

  Gateway Looks to the host computer like an IBM 3174 supporting up to 32 display or printer sessions. It communicates to the Network Stations on one side (providing the Controller function) and to the host on the other.

  Network Station Emulates a display or printer session, communicating to the host through the IBM PC 3270 Emulation Program Gateway.

Refer to the *IBM PC 3270 Emulation Program User's Guide* for detailed information about this program.

The OS/2 Communication Manager (a feature available with OS/2) provides all the services of the IBM 3270 Emulation Program for personal computers used in an OS/2 environment.

IBM Personal Communications/3270 Emulation Program

The IBM Personal Communications/3270 Emulation Program provides all the services of the IBM PC 3270 Emulation Program and also integrates the services of the IBM PC 3270 Emulation LAN Management Program. This program does not require the NETBIOS interface.

Refer to the *IBM Personal Communications/3270 Emulation Program User's Guide* for detailed information about this program.

IBM Asynchronous Communications Server Program

The Asynchronous Communications Server Program provides an asynchronous communication gateway for IBM workstations connected to a LAN. Workstations on the LAN can share the server program's communication equipment:

- A modem internal to the server computer
- An external modem connected to the server computer's serial port
- A direct connect device connected to the server computer's serial port.

The server can communicate over switched asynchronous communication lines or can interact directly with nonswitched devices. For one or two asynchronous communication lines, the Communications Server Program:

- Makes outgoing switched connections
- Sets communication parameters
- Accepts incoming calls
- Buffers and transfers incoming data for other workstations on the LAN.

LAN application programs can use the server program to place calls to and receive calls from information services, ASCII host computers, or other IBM personal computers. The application program can place calls or receive calls through the public switched network. The IBM Asynchronous Communications Server Program uses the Asynchronous Communications Server Interface (ACSI) to transport commands and ASCII data from other workstations on the network. The ACSI protocol is also used by the IBM Asynchronous Connection Server Program.

The IBM Asynchronous Communications Server Program:

- Requires the NETBIOS interface
- Supports two communication adapters if they use the same modem type, line speed, and functional features
- Supports Public Switched Network (PSN) or Private Branch Exchange (PBX) equipment
- Uses a configuration file for the information required to direct calls and make connections
- Provides a sample communication application program that lets you verify server installation and assists with problem resolution.

Refer to the *IBM Asynchronous Communications Server Program Installation and Configuration Guide* for detailed information about this program.

IBM APPC/PC Program

The IBM Advanced Program-to-Program Communication Program for the IBM Personal Computer (APPC/PC) is a data communication system that enables IBM Personal Computer application programs to communicate with:

- Other IBM Personal Computer application programs that use the APPC/PC program
- An APPC program on other systems (such as System/36 or 38, Series/1, or System/370 or System/390).

The APPC/PC program does not provide a gateway function. Rather, it enables using a gateway function by providing distributed transaction processing capability, through an Application Program Interface (API) that supports the LU 6.2 interface.

To use APPC/PC, you must supply an application subsystem that provides services to the APPC/PC program and to your transaction programs. The application subsystem manages the services not managed by the APPC/PC program, including:

- Logging errors
- Managing incoming conversations
- Loading transaction programs
- Activating adapters
- Defining the logical characteristics of partner nodes (LUs, PUs, and sessions, for example).

Refer to the *Advanced Program-to-Program Communication for IBM Personal Computer Installation and Configuration Guide* for more information about the APPC/PC program.

IBM LAN to LAN Wide Area Network Program

The LAN to LAN Wide Area Network Program (LTLW) enables a station using the IBM NETBIOS protocol on one LAN to communicate with a station using the IBM NETBIOS protocol on another LAN by sending the frames across a WAN that connects the two LANs. Each of the LANs must have an LTLW station, and that station must be able to communicate with another LTLW station through the WAN. The LTLW station transmits the frames received from the source LAN station across the WAN to the other LTLW station, which forwards the frames to the target LAN station.

The NETBIOS sessions use link station connections established at the IEEE 802.2 interface level. (The LTLW does not support communication with LAN stations running the version of NETBIOS provided by the IBM PC Network Protocol Driver.)

Sessions on the WAN between the two LTLW stations use Advanced Program-to-Program Communication (APPC), the IBM implementation of LU type 6.2. The LTLW stations appear to the WAN components as independent LUs.

The first LTLW station:

1. Appends APPC headers to the frames sent to it by the source LAN station during a NETBIOS session.
2. Sends the encapsulated NETBIOS frames to the second LTLW station (its partner LU) via an LU-LU session that conforms to the APPC protocol.

The second LTLW station:

1. Removes the APPC headers
2. Sends the NETBIOS frames to the target LAN station.

Therefore, the LTLW enables end-to-end NETBIOS sessions between a source and a target LAN station.

The OS/2 EE 1.2 or higher Communications Manager is used to provide support for APPC sessions across the WAN and support for IEEE 802.2 sessions on the LAN. The LTLW operates on any personal computer that is supported by OS/2 EE Version 1.2 or higher and has the necessary adapter expansion slots. The LTLW station is connected to the LAN by a LAN adapter and cable.

The physical connection from the LTLW station into the WAN may be through any of the adapters supported by the LU 6.2 interface of the OS/2 EE Version 1.2 or higher Communications Manager. These adapters include LAN, SDLC, and X.25 adapters.

The connection through the WAN is an LU 6.2 session between LTLW stations. When using an SNA backbone, these sessions are routed through IBM communication controllers using NCP (3720, 3725, 3745, or 3174 with RPG 8Q0800) or are routed through an IBM 9370 with Integrated Communication Adapter using VM/9370. When the connection is across an X.25 network, these sessions are routed through IBM communication controllers that contain NCP and the NCP Packet Switching Interface (NPSI) (3720, 3725, 3745, or 3174 with RPQ 8Q0800). In order to use X.25, a virtual circuit is defined for each LTLW-to-LTLW connection, but these virtual circuits can be multiplexed into one X.25 link.

All sessions require PU 2.1 support in the intermediate communication controllers (see WAN software requirements on page 1-6). Refer to the *IBM LAN to LAN Wide Area Network Program Users Guide* for more information about the LTLW program.

Relationship to Other Applications

Because of LTLW memory requirements, the LTLW should be started before starting other applications in the LTLW computer.

Software

In the LTLW station:

- Operating System: IBM OS/2 EE Version 1.2 or higher
- Connection to the WAN and LAN: IBM OS/2 EE Version 1.2 or higher Communication Manager
  - WAN: APPC (LU 6.2) interface
  - LAN: IEEE 802.2 interface.

In the WAN (for an SNA network):

- In a backbone SNA network using SDLC links to IBM 3720, 3725, or 3745 communications controllers:
  - ACF/VTAM: Version 3.2 or higher
  - ACF/NCP for IBM 3745 and 3720 controllers: Version 5.2 or higher
  - ACF/NCP for IBM 3725 controller: Version 4.3 or higher
- In an SNA network using SDLC links to an IBM 9370 with Integrated Communication Adapter:
  - ACF/VTAM: Version 3.2 or higher
  - VM/9370 for IBM 9370 and ICA: Version 3.3 or higher
- In a connection across an X.25 network, with X.25 virtual circuits connecting to IBM 3720, 3725, or 3745 communications controllers:
  - ACF/NCP (with compatible level of NCP Packet Switching Interface (NPSI), for IBM 3745 and 3720 controllers: Version 5.2 or higher
  - ACF/NCP (with compatible level of NCP Packet Switching Interface (NPSI), for IBM 3725 controller: Version 4.3 or higher
- In a backbone SNA network using SDLC links from a 3174 Establishment Control Unit with RPQ 8Q0800 to an IBM 3720, 3725, or 3745 controller:
  - ACF/VTAM: Version 3.2 or higher.

IBM 3172 Interconnect Program

The IBM 3172 Interconnect Controller Program runs on an IBM 3172 Interconnect Controller allowing it to establish communication between a host computer and any of the following LANs:

- IBM 4-Mbps Token-Ring Network
- IBM 16-Mbps Token-Ring Network
- Ethernet Network
- MAP Network.

Note: Each MAP 3.0 adapter requires two of the four LAN adapter slots in the IBM 3172, so the number of LANs must also be reduced accordingly.

The host computer can be any one of the following:

- IBM 9370
- IBM 4361/4381
- IBM 308x/3090.

There are four possible configurations for the IBM 3172 Interconnect Controller.

- A 3172 Base Unit provides communication between one or two host computers and up to four LANs.
- Configuration 1, consisting of a 3172 Base Unit mounted in a 9309 Rack, provides communication between one or two host computers and up to four LANs.
- Configuration 2, consisting of two 3172 Base Units mounted in a 9309 Rack, provides communication between as many as four host computers and up to eight LANs.
- Configuration 3, consisting of three 3172 Base Units mounted in a 9309 Rack, provides communication between as many as 6 host computers and up to 12 LANs.

Device Emulation Programs

Device Emulation Programs enable communication between devices by modifying the characteristics of one device so that it appears to be another type of device.

IBM 3270 Workstation Program

The IBM 3270 Workstation Program replaces and enhances the function of the IBM 3270-PC Control Program. The new Version 1.1 allows workstations to be host-connected across a Token-Ring network using IEEE 802.2 Protocols.

IBM Token-Ring Network workstations running the IBM 3270 Workstation Program can communicate with a host computer over the Token-Ring network without the need for an IBM 3270 controller.

The Workstation Program provides:

- Multitasking
- Multiple host sessions (0 to 4)
- Multiple DOS sessions (0 to 6)
- Attachment to an IBM 3174 Establishment Controller or an IBM 3274 Control Unit in Distributed Function Terminal (DFT) or Control Unit Terminal (CUT) mode
- Attachment support of Token-Ring network workstations that communicate
  - Through IBM 37XX or IBM 3174 Gateways with S/370 hosts
  - Directly with the IBM 9370
- Expanded memory support (up to 2.25 MB)
- Windowing
- Support for the IBM Token-Ring Network
- Support for the IBM 9370 Computer and the IBM 3270 Control Unit as Token-Ring gateways for host access, using IEEE 802.2 protocols.

Refer to the *IBM 3270 Workstation Program Setup and Customization* manual for detailed information about this program.

IBM PC 3270 Emulation Program

The IBM PC 3270 Emulation Program provides IBM 3270 emulation services for an IBM PC or PS/2 connected to a LAN. For a description of this program, see "Gateway Programs" on page 16-6.

IBM Personal Communications/3270 Emulation Program

The IBM Personal Communications/3270 Emulation Program provides IBM 3270 emulation services for an IBM PC or PS/2 connected to a LAN. For a description of this program, see "Gateway Programs" on page 16-6.

Server Programs

Server Programs enable a workstation on a LAN to access and use services such as printing and file storage as though these services are local and dedicated to any particular workstation.

IBM PC LAN Program

The IBM PC LAN program runs only in a DOS environment. This program provides resource sharing for interconnecting workstations on the IBM Token-Ring and IBM PC Networks. It includes extended services enhancements for the administration of LAN server resources. Highlights of the IBM PC LAN Program are:

- Sharing data files among users
- Sharing printers among those who need printer access
- Sending electronic messages to other devices on the LAN
- Providing security by limiting access to directories and programs
- Support by the IBM OS/2 LAN Server Program
- Version 1.3 Extended Services
  - Central resource definition and control
  - Single system image of multiple servers
  - Encrypted passwords
  - Administrator password from any workstation
  - Application selector menu support
  - Remote initial program load (IPL) support.

  Note: The IBM PC LAN Program should not be installed on a Workstation that will invoke the Remote IPL process.

The IBM PC LAN Program must be used with either the IBM LAN Support Program or the IBM PC Network Protocol Driver Program. Installation of extended services requires that one device on the LAN is a server. Additional devices may be either servers or workstations.

Refer to the *IBM PC LAN Program User's Guide* for detailed information about this program.

LANACS

Refer to the *IBM Local Area Network Asynchronous Connection Server (LANACS) Program Installation and Configuration Guide* for detailed information about this program.

LANACS runs in a dedicated workstation (or server) connected to either an IBM Token-Ring Network, IBM PC Network, or an Ethernet. LANACS provides asynchronous communication services for LAN workstations and off-LAN devices. Off-LAN devices can be:

- ASCII host computers
- ASCII terminals
- IBM 7171 ASCII Device Attachment Control Units
- IBM workstations (using ASCII emulation)
- Devices attached to a ROLM Computerized Branch Exchange (CBX).

LANACS operating in a LAN-attached PS/2 workstation can reside on an IBM Token-Ring Network, on an IBM PC Network, or on an Ethernet.

It provides DOS, OS/2, and TCP/IP Telnet LAN-attached workstations access to Off-Net Asynchronous ASCII functions such as:

- ASCII hosts directly connected to LANACS
- ASCII hosts on Ethernet (not TCP/IP), accessed through a Network Interface Unit connected to Ethernet and to LANACS
- Modem Pools to dial out to ASCII Hosts, or Information Providers.

LANACS provides DOS or OS/2 LAN attached workstations access to:

- TCP/IP hosts in Telnet Line Mode
- LAN-attached IBM TCP/IP host through 3270 protocol conversion (Telnet TN 3270).

For more information, refer to the LANACS supporting documentation.

LANACS allows LAN workstations access to asynchronous devices attached to the server workstation's outgoing ports. The server operating in the incoming mode will, on behalf of devices attached to its incoming ports, allow access to on-LAN workstations and will obtain access to outgoing ports. Servers can have both incoming and outgoing ports defined. Off-LAN devices can be attached directly to a server or indirectly through a modem.

Multiple servers may reside on a LAN. An off-LAN device connected to any one server may communicate with any workstation on the LAN. This same off-LAN device may also communicate through its server with another off-LAN device connected to its server. The figure below illustrates both cases.

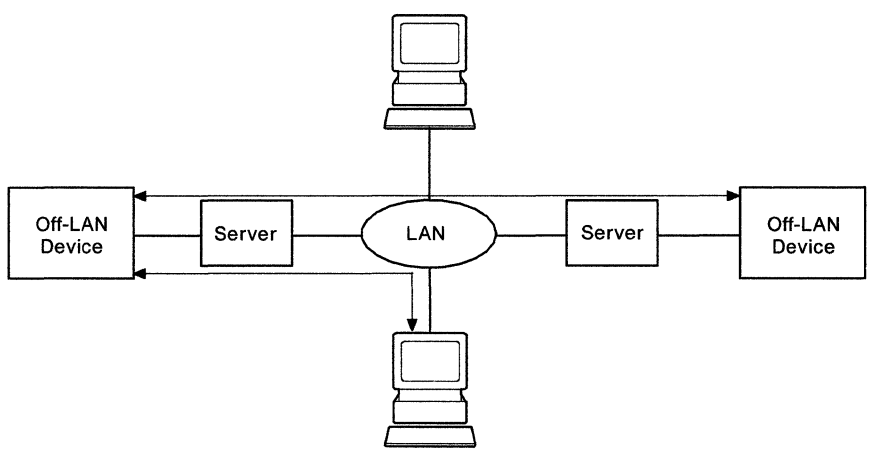

Figure 16-2. Communication via the IBM LAN Asynchronous Connection Server Program

Software Interfaces

The following four software interfaces communicate between LAN workstations and the server:

- Enhanced Basic Input/Output System (BIOS) Interface (EBI)
- Asynchronous Communications Server Protocol Interface (ACSI)
- Asynchronous Communications Device Interface (ACDI)
- Line mode emulation on Transmission Control Protocol/Internet Protocol (TCP/IP) Telnet.

The first three of these interfaces (EBI, ACSI, and ACDI) use the LAN's NETBIOS interface to send the asynchronous data from the terminal emulation program to the server. Telnet emulation sends its data across the LAN using TCP/IP.

The EBI and ACDI interfaces are available only under the DOS and OS/2 operating systems, respectively. The ACSI can be used only under an operating system where a NETBIOS interface is available. Telnet is available for DOS, OS/2, AIX (and most other UNIX implementations), MVS, VM, and several other non-IBM operating systems.

The EBI interface embraces the primitive hardware interface simulating the presence of an imaginary direct communications line between the LAN workstation and the end point. When IBM LANACS Version 2.0 is operating in port contention mode, the EBI notifies requesting application programs that the server is running but that there are no more ports available. This notification is generated by EBIOS.COM and can be used by LANACS Version 1.1, FTTERM 2.1 Level 3, and modified application programs. EBI presents the connection to the server as if it were the COM1 through COM4 device on the workstation. The EBIOS Redirection command, however, redirects the COM port to the LAN, so these four COM ports are virtual COM ports when directed. Note that a LAN workstation can still use a COM port as a real COM port as long as it is not redirected to the LAN as part of the LAN operation. Judicious use of batch files and dialing scripts can eliminate the need for repetitious details when using EBI.

The ACSI protocol is a high-level interface with commands and return codes as well as simple data transfer. However, the program must be designed in terms of NETBIOS calls. The principle difference between the EBI and ACSI protocols is that with EBI the application user presents the connection request as a netname or presents dial digits to the modem. With ACSI, the application user always presents a target. This target request can result in a connection to an ASCII device or relate to a phone number, which the server dials.

The ACSI is the interface for OS/2 workstations. Choosing either EBI or ACDI in the configuration allows the operation through a designated port or allows port-contention with a DOS workstation using EBI.

Telnet emulation is usually supplied with a TCP/IP program package (for DOS or OS/2) or is part of the AIX or UNIX operating system.

IBM Operating System/2 LAN Server Program

The OS/2 LAN Server Program is similar to the IBM PC LAN Program but runs in an OS/2 environment. This program provides LAN services to workstations on the IBM Token-Ring Network and IBM PC Networks. Communication across the LAN is accomplished through IEEE 802.2 and NETBIOS protocols, whereas communication with a host computer is enabled by the OS/2 Extended Edition Communications Manager. The OS/2 LAN Server Program:

- Uses IBM OS/2 Extended Edition functions
- Supports resource sharing for files, printers, and serial communication devices
- Provides multiple security services to protect resources
- Offers extensive printer management capabilities with concurrent support for up to four printers
- Provides remote initial program load support for PC DOS workstations
- Executes programs on remote workstations
- Provides administrative services.

Both OS/2 requestors and PC DOS requestors may connect to the OS/2 LAN Server, although the requestor's hardware and software requirements differ. Workstations using IBM OS/2 Extended Edition do not require the IBM LAN Support Program. An equivalent function is included as part of the OS/2 Communications Manager.

The OS/2 Communications Manager supports the following:

- IBM 3270 Emulation — IBM 37XX or 3174 gateway required
- IBM APPC — IBM 37XX gateway required
- Asynchronous communications — sharing serial devices.

The NETBIOS interface limits the number of sessions in a domain to 254. Each OS/2 requestor logged on to the server uses one session, whereas each PC DOS requestor running the IBM PC LAN Program uses two.

Note: Support is not available for IBM PC LAN Program server stations to communicate with IBM OS/2 LAN Server stations and they cannot exist within the same domain. Also, IBM PC LAN Program requestors are not able to access some IBM OS/2 LAN Server resources such as serially attached devices.

Refer to the *IBM Operating System/2 LAN Server Program User's Guide* for detailed information about this program.

Remote Connection Programs

Remote connection programs allow workstations not physically connected to a LAN to appear to other devices on the network as though they are physically connected to the network.

IBM Remote NETBIOS Access Facility Program

The IBM Remote NETBIOS Access Facility Program provides access to IBM LANs for NETBIOS application programs running in IBM Personal Computers and Personal System/2 computers that are not physically connected to the LAN (remote computers).

The Remote Facility of the Remote NETBIOS Access Facility Program allows the user of a remote computer to establish a connection through a public or private switched network to a personal computer that is directly connected to the LAN.

The directly connected computer uses the LAN-Gateway Facility of the Remote NETBIOS Access Facility Program to support LAN access for up to 255 remote computers (though only two may concurrently connect to the network). Up to three LAN-Gateway Facilities may be loaded in a single PS/2 computer (Model 60, 80, or 95), allowing up to six concurrent connections per PS/2 computer. Multiple PS/2 computers may be used to provide the desire concurrent connections. The LAN-Gateway Facility:

- Manages NETBIOS-equivalent logical connections between each remote computer and LAN applications and servers
- Handles data transfer between the remote computer and the LAN
- Directs data to the correct destination on the LAN
- Maintains the remote connection until it is terminated by the user, the LAN-Gateway Facility or Remote Facility (due to inactivity), or communication difficulties.

Both the LAN-Gateway computer and the remote computer require appropriate hardware for asynchronous communication (an adapter, a modem, or both) and the Remote NETBIOS Access Facility Program. The LAN-Gateway computer also requires a LAN adapter and programs to connect to the LAN and to support the NETBIOS interface.

Other features of the Remote NETBIOS Access Facility Program include:

- LAN-Gateway Facility sharing of asynchronous ports and lines with the IBM Asynchronous Communications Server Program (this function is not available in the U.S.)
- LAN access security through user identifications, passwords, and dial-back support
- Configuration and installation aids
- Programs to support the use of the NETBIOS Trace command and to produce formatted trace results.

Refer to the *IBM Remote NETBIOS Access Facility Program Installation and Configuration Guide* for detailed information about this program.

Chapter 17. Operating Systems

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The following Operating Systems and Subsystems support application programs operating on the indicated LANs:

Operating System	IBM Token-Ring Network	IBM PC Network		Ethernet	Map
		Broadband	Baseband		
IBM PC Disk Operating System (PC DOS)	Yes	Yes	Yes	No	No
IBM Operating System/2 (OS/2) including OS/2 Communications Manager	Yes	Yes	Yes	Yes	Yes
IBM Multiple Virtual System (MVS)	Yes	Yes	Yes	Yes	Yes
IBM Virtual Machine/System Product (VM/SP)	Yes	Yes	Yes	No	No
IBM Advanced Interactive Executive (AIX) Operating System	Yes	Yes	Yes	Yes	Yes
IBM Operating System/400*	Yes	Yes	No	No	No
IBM System/36 or 38 System Support Program (SSP)	Yes	Yes	No	No	No
IBM Series/1 Operating Systems	Yes	No	No	No	No

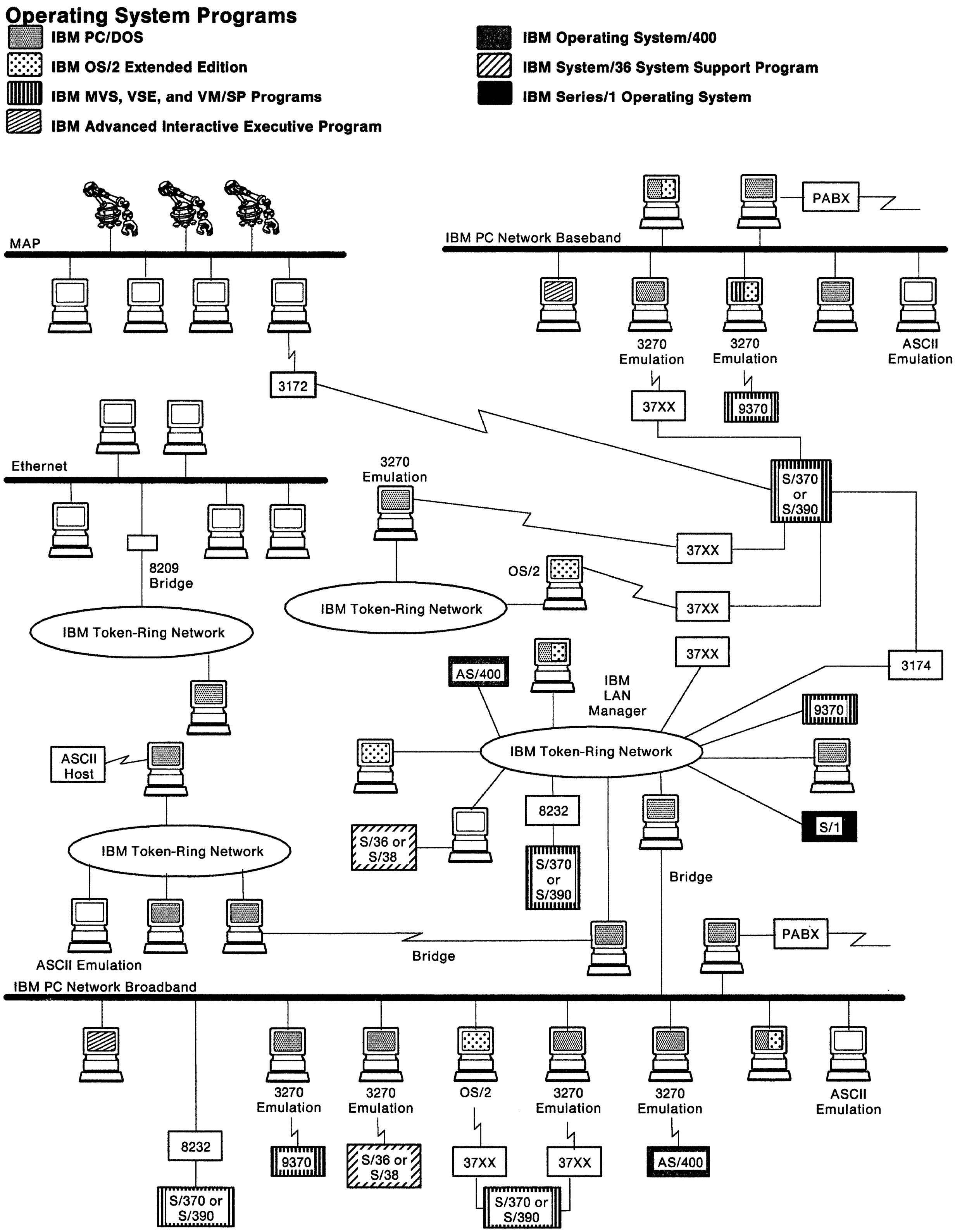

Figure 17-1. Operating System Programs Used on a LAN

Overview

All computers have an Operating System. Some operating systems are used on several different types of computers; others are unique to a specific computer. In either case the operating system controls a computer's input and output operations, manages its internal operations, and provides the environment in which application programs run.

The table on page 17-1 identifies specific operating systems and subsystems that support application programs running in computers that are communicating through the indicated LAN. Figure 17-1 shows the equipment that could be connected to a LAN and identifies the operating system or subsystem needed for this equipment. The remainder of this chapter discusses each operating system and subsystem in detail.

Preparing Working Copies of Programs and Files

Purchased program products are usually supplied on diskettes or magnetic tapes and may be packaged with hardware, *User's Guides*, or *Operator's Guides.*

In order to prevent damage to original diskettes, and to prepare the programs for operation, you should copy the programs from the original diskettes to working diskettes or fixed disks. DOS or another operating system may be required to create the working copies and to load the programs. Files that are needed to load the programs or to provide parameters and options are copied to or created on the same disk or diskette.

Programs and files supplied on tapes or other media are usually copied to disk storage on a computer system. The programs and files are generally used as input to a process (such as system generation, compilation, or linkage edit) that prepares programs to run on the computer system or in a device attaching to it.

If you write programs and interfaces for your network, they also will need working copies and an original copy that is protected from damage.

See Chapter 9 for more information on preparing working copies and files, filing and storing the original tapes and diskettes, choosing options and parameters, allocating resources, and writing your own programs and interfaces.

DOS in a LAN

Many communications capabilities are introduced to the network in the form of DOS device drivers. In order to get the communications functioning, the appropriate drivers must be installed and recognized in the CONFIG.SYS file.

IBM PC Disk Operating System (PC DOS)

Since the introduction of the IBM Personal Computer, IBM Personal Computer Disk Operating System (PC DOS) has been available. PC DOS has an open architecture and is compatible with many applications intended to run on the PC. Each new version of PC DOS provides additional function while maintaining compatibility with previous versions. PC DOS runs on IBM PCs and IBM PS/2 computers. If you want to port DOS applications to OS/2, see "DOS Mode of OS/2 Extended Edition" on page 17-5.

Refer to the *IBM Personal Computer Disk Operating System Reference* manual for detailed information about this operating system.

IBM Operating System/2

IBM OS/2 is a multitasking operating system that runs in IBM PS/2 computers and the IBM Personal Computer AT. OS/2 is available in a Standard Edition and an Extended Edition. The Extended Edition Version 1.1 or higher provides the functions required for connecting PS/2 computers to LANs.

OS/2 Standard Edition

The features of the Standard Edition include:

- 16 MB of addressable memory
- Ability to run multiple applications concurrently

  OS/2 can run up to 12 application programs concurrently, 1 of which may be a PC DOS application program.
- A PC DOS environment

  Many existing application programs written for PC DOS can run under OS/2. OS/2 suspends processing activity in the PC DOS environment during interaction with an OS/2 application program. However, processing in other OS/2 applications continues. For this reason, not all PC DOS application programs will run in the OS/2 – PC DOS environment (especially those that are time dependent).
- A Presentation Manager

  The Presentation Manager is a user interface that:

  – Divides the display screen into "windows" that show multiple sessions or application programs at one time

  – Allows full graphics capabilities.

DOS Mode of OS/2 Extended Edition

OS/2 and DOS are the two operating modes provided by the OS/2 system, and they affect the processing of programs and commands differently. *OS/2 mode* refers to the multiprogramming environment that allows you to run more than one program written for the base operating system. *DOS mode* refers to the environment that is similar to the IBM Disk Operating System Version 3.30.

Each mode has its own command processor to interpret and run operating system commands. Most of the commands work in both modes; however, there are some commands that provide functions specific to only one mode.

DOS programs are limited to 640 KB and can run only within the first MB of system storage.

In DOS mode, only one DOS command processor can process a command or program at a time. Thus, only one DOS program can run at a time, and the program is processed only when displayed on your screen. For example, if you are working with a DOS program and you return to Presentation Manager, the DOS program stops running and only begins running again when you return to the program. If the DOS program was keeping track of the time of day by counting clock ticks, the program may have an incorrect time when it resumes.

Not all programs written for IBM DOS will run in DOS mode. For information that may help you decide if your program will run successfully in DOS mode, refer to your OS/2 documentation.

OS/2 Extended Edition

IBM OS/2 Extended Edition is an enhanced version of OS/2 Standard Edition. The enhancements include:

- A Communications Manager
- A Presentation Manager
- A Database Manager.

Communications Manager

The Communications Manager lets a user access multiple computers and provides a broad range of communications capabilities, including:

- SNA Communications
- Asynchronous Communications
- LAN Support.

SNA Communications

Since the OS/2 program provides multitasking capability, the various communications options can usually be run concurrently. In many cases, this eliminates the need to load and unload programs to communicate with different systems.

The functions provided by Communications Manager for communications within an SNA network are:

- 3270 terminal emulation
- SNA Advanced Program-to-Program Communication (APPC)
- Server-Requestor Programming Interface (SRPI)
- Emulator High-Level Language Application Programming Interface (EHLLAPI).

The Communications Manager 3270 terminal emulation operates in two basic environments. One method consists of connecting to a host through an IBM 3174 or 3274 terminal controller, or through the workstation adapter of an IBM 9370, by way of a 3278/79 emulation adapter. This connection supports the Distributed Function Terminal (DFT) interface for either SNA or non-SNA protocol. The other method supports a Synchronous Data Link Control (SDLC) or IBM Token-Ring Network connection to an IBM 3705, 3720, 3725, or 3745 communications controller or the communications controller of an IBM 9370 or 3174 with the gateway feature using the IBM Token-Ring.

A maximum of ten 3270 sessions can be active at any one time. This total of 10 sessions consists of up to 5 DFT sessions and up to 5 other sessions that can be *either* SDLC *or* IBM Token-Ring connections.

In addition to terminal emulation, an active 3270 session can be used to move data between the personal computer and the IBM System/370 or System/390 host. This file transfer capability provides a means of exchanging data or text with the host system.

Communications Manager provides an APPC Application Programming Interface (API) for programs that perform distributed transaction processing. An application program, called a *Transaction Program* (TP), using APPC can communicate with TPs on other systems that support SNA APPC.

Advanced Program-to-Program Communications is suited to full-function synchronous communications in a peer-to-peer environment. APPC uses SNA Logical Unit (LU) type 6.2, which is included in the IBM System Application Architecture, as the base for distributed transaction applications between a range of IBM systems. For more information, refer to the *APPC Programming Reference*.

A Server-Requestor Programming Interface (SRPI), around which cooperative processing applications can be built, is part of Communications Manager. This allows the personal computer or Personal System/2 to act as a requestor. Requests are routed through an active 3270 session over an LU type 2 to a host server (CMS or TSO).

With Communications Manager, multiple SRPI applications programs can be active at any one time. You must establish a link to an appropriate host server interface in CMS or TSO through one of the available 3270 sessions. While an application program is using SRPI, the 3270 session cannot be used for interactive work or file transfer.

The Emulator High-Level Language Application Programming Interface (EHLLAPI) provides an interface to IBM 3270 Emulation. The supported interface is from the application program on a workstation to application objects such as a keyboard, sessions, screens, presentation spaces, the cursor, and the Operator Information Area (OIA) on a host session. There are five service groups in EHLLAPI. These groups are:

- Operator services
- Presentation services
- Device services
- Communications services
- Utility services.

For more information, refer to the *Emulator High-Level Language Application Program Interface Programming Guide*.

Asynchronous Communications

The functions provided by Communications Manager for communications in an asynchronous network are:

- ASCII Terminal Emulation
- Asynchronous Communications Device Interface (ACDI).

An IBM personal computer, connected through an asynchronous link to a suitable host, can emulate one of the following terminals:

- IBM 3101
- DEC VT100.

ASCII terminal emulation provides the following:

- Asynchronous access to IBM System/370 or System/390 host computers through a suitable protocol converter to emulate an IBM 3101 or DEC VT100 terminal
- Access to other IBM computers, such as the IBM RT PC (6150) and Series/1

- Access to non-IBM hosts that support either IBM 3101 or DEC VT100
- Access to a range of data services such as Dow Jones News/Retrieval Service, Compuserve Information Service, MCI Mail, or The Source.

File transfer can be performed over an asynchronous link:

- To an IBM host (VM/CMS or MVS/TSO) using the 3270-PC File Transfer Program (IND$FILE)
- To a suitably configured asynchronous host using the XMODEM protocol.

Since file transfer occurs through the active ASCII terminal emulation session, only one asynchronous file transfer can be active at any one time. However, the asynchronous file transfer can be concurrent with 3270 file transfers.

Asynchronous Communications Device Interface (ACDI) is a programming interface that provides support for using the serial ports in a multitasking environment. ACDI provides an interface to the asynchronous communications function. This function interacts with the serial ports through the operating system and ensures that interrupts are handled and data is buffered for applications as required.

ACDI contains verbs that enable the programmer to set features such as word length and XON/XOFF characters, as well as the necessary verbs for sending and receiving data through the serial port. In this way, a programmer can develop and use an asynchronous communications protocol without having detailed knowledge of the asynchronous communications hardware or device drivers. In addition, applications written to ACDI should not need modification if hardware or device drivers are changed. For more information, refer to the *ACDI Programming Reference*.

LAN Support

LANs provide a method for connecting intelligent devices together within a location. For personal computers, LANs can provide access to host computers (both IBM and non-IBM) and departmental processors, as well as sharing of personal computer resources (such as disk space, files, and printers). In addition, a number of programming interfaces allow the development of applications between devices connected on the LAN.

Two LANs are supported by IBM Operating System/2 Extended Edition Version 1.1 or higher and Communications Manager:

- IBM PC Network (Broadband and Baseband)
- IBM Token-Ring Network.

Application programs can use any of the three interfaces below for communications to other personal computers on the same LAN:

- IEEE 802.2 (Direct interface and DLC interface)
- Advanced Program-to-Program Communications (APPC)
- NETBIOS.

The IEEE 802.2 LLC interface is a low-level interface to LANs. It is an implementation of the IEEE 802.2 standard for LANs. Both the APPC support and the NETBIOS support provided within Communications Manager use the IEEE 802.2 interface for access to the LAN.

The interface is supported by two control block structures. One structure allows access to the IEEE 802.2 dynamic link routines (DLRs). The other structure accesses the device drivers directly.

For more information, refer to the *IBM Local Area Network Technical Reference.*

The NETBIOS programming interface provides a high-level interface for personal computers communicating on a LAN.

The NETBIOS interface under IBM OS/2 EE provides compatibility with existing NETBIOS applications running under PC DOS. It is also used by the LAN requestor component of the OS/2 program. For more information, refer to the *IBM OS/2 LAN Server Network Administrator's Reference.*

Database Manager

The Database Manager provides a database subsystem with the following features:

- Interactive query and report writing
- Consistency with IBM relational database products
- LAN support
- Remote Data Services.

Presentation Manager

Presentation Manager provides a window-driven way to manage your information, giving you easy accessibility to OS/2 functions. Through Presentation Manager, your system can perform several tasks together so that you can use one set of data in conjunction with another. For example, you might need to stop one application program to run another program. With the Presentation Manager, you can view many tasks simultaneously on a screen and also copy data from one task to another. Other aspects of Presentation Manager allow you to:

- Start commands or program applications
- View and edit data files in the system
- Store, retrieve, or print files or directories
- Display output from multiple applications on the screen simultaneously
- Control various aspects of the appearance and operation of the system such as position, size, visibility, or color of windows
- Control printers and plotters attached to your system
- Maneuver files from one window to another.

Refer to the *IBM Operating System/2 Extended Edition Version 1.1 Command Reference* manual for detailed information about this operating system.

IBM MVS

IBM Multiple Virtual System (MVS) is the virtual storage operating system designed to perform the system control program functions in large-system environments.

The architecture and design of MVS accentuate the integrity, data security, high availability, and performance of the system. These characteristics are important in heavily used online, interactive environments in which response time, flexible resource utilization, and operational controls are required.

Function, Facilities, and Features of MVS include:

- Virtual storage operating system supporting uniprocessor, attached processor, and tightly or loosely coupled multiprocessor configurations
- Individual address space for each Time Shared Option (TSO) user
- System resource manager (SRM) for dynamic workload management
- System-wide dynamic allocation/de-allocation of data sets
- Virtual Storage Access Method (VSAM) master catalog and user catalog
- Virtual input/output (VIO) for temporary data sets
- Functional recovery routines for system components
- Job entry functions supported by job entry subsystems, JES2 or JES3.

Refer to the *IBM Network Program Products: General Information: MVS, VM, VSE* manual for more information about this operating system.

IBM VM/SP

IBM Virtual Machine/System Product (VM/SP) is an interactive, multiple-access operating system, simulating a real computer and its associated devices and resources, that many users can share. VM/SP provides file management, an English-like command language, and a full-screen editor. A wide range of application programs are available to complement the basic functions of VM/SP, which are:

- Problem solving
- Editing and text creation
- Program development
- Application program testing
- System program testing
- Configuration simulation.

VM/SP has six basic components:

1 Control Program

The **Control Program** (CP) creates the system work environment (virtual machine) for each user in a VM/SP work session. The resources managed by the Control Program include:

- Processor functions
- Processor storage
- Input and output (I/O) devices.

2 Conversational Monitor System

The **Conversational Monitor System** (CMS), although a component of the VM/SP operating system, is itself an operating system, providing an interface between the user and the control program. Communicating through CMS commands you can:

- Write, test, and debug application programs
- Create and edit information files
- Run application programs
- Process jobs in batch mode
- Manage the CMS working environment
- Communicate with other users
- Share information with other users.

3 Group Control System

The **Group Control System** (GCS) is a virtual machine supervisor that manages multiple tasks. It manages subsystems that support an SNA network.

4 Advanced Program-to-Program Communication/VM VTAM Support

The **Advanced Program-to-Program Communication/VM VTAM Support** (AVS) enables VM users to connect to and communicate with an SNA network. AVS runs in a GCS group and requires ACF/VTAM to communicate with an SNA network.

5 Transparent Services Access Facility

The **Transparent Services Access Facility** (TSAF) virtual machine lets users connect to and communicate with other APPC/VM application programs.

6 Interactive Problem Control System.

The **Interactive Problem Control System** (IPCS) is an online facility that diagnoses and reports software failures and manages problem information and status.

Refer to the *IBM VM/SP Planning Guide and Reference* manual for more information about this operating system.

IBM Advanced Interactive Executive (AIX) Operating System

The IBM Advanced Interactive Executive Operating System is a multi-user, multitasking, virtual memory operating system consistent with AT&T UNIX** System V and Berkeley Software Distribution (BSD), and with IBM enhancements.

UNIX operating system characteristics:

- Programs written in the C language are usually portable from one UNIX system to another.
- UNIX operating systems are interactive multi-user systems.
- UNIX operating systems include these components:

  Kernel A hardware interface that provides services for other system layers (system calls, file system support, device drivers)

  Shell A flexible interface between user and system; a command interpreter with programming facilities and I/O redirection

  File System Manages files and directories with user access authorization.

AIX Versions

There are versions of AIX for IBM System/370 or System/390 computers, selected models of the IBM PS/2 computer, and the IBM Reduced Instruction Set Computers (IBM RT PC and RISC System/6000):

- AIX/370
- AIX PS/2
- AIX/RT.

Refer to the manual for the appropriate version of AIX for more information about these operating systems. Appendix A contains a complete list of reference manuals.

IBM Operating System/400

IBM Operating System/400 is the operating system for the IBM AS/400 computer. It enables end users, programmers, and system operators to access menus and displays that control the basic operation of this computer.

Key functions, facilities, and features of OS/400 include:

- Single integrated operating system for all models
- Installation, use, and maintenance aids
  - Menu interface to most system functions
  - Automatic configuration for local devices
  - Online help
  - System operation
  - Operating system installation/modification
  - Problem determination
  - Copy screen function
  - Program Temporary Fixes (PTFs)
- Application development environment support
- Database functions

  The IBM AS/400 relational database is integrated into both the machine and operating system and provides functions that allow for a high degree of data integrity and programmer productivity, including:
  - Access path definition
  - File definition
  - Field reference file
- Comprehensive security
  - Minimal — No passwords used; any user can perform any function
  - Password — Passwords used; any authorized user can perform any function
  - Resource — Passwords required; users are restricted to specific functions
- Application program interface to system functions
- Multiple operating environments
  - System/34 application programs
  - System/36 or 38 application programs
  - System/38 application programs
- Online customer support
- Online education

- Connections to remote devices, systems, and networks
  - Supported protocols and networks:
    - IBM Token-Ring Network
    - Asynchronous Communication (Async)
    - Binary Synchronous Communication (BSC)
    - Synchronous Data Link Control (SDLC)
    - X.21 networks
    - X.25 networks
  - Supported network management facilities:
    - Alerts support to NetView, System/36 or 38, System/38, AS/400
    - IBM Token-Ring Network management support
    - Distributed Host Command Facility (DHCF)
    - Link Problem Determination Aid (LDPA)
    - Distributed System Node Executive (DSNX)
  - Supported communications facilities:
    - Remote workstation support
    - Intersystem Communications Function (ICF)
    - Advanced Peer-to-Peer Networking (APPN)
    - Advanced Program-to-Program Communication (APPC)
    - SNA Distribution Services (SNADS)
    - Network configuration menu
    - Display station pass-through
    - Distributed Data Management (DDM)
    - SNA upline facility to System/370 or System/390 IMS and CICS hosts
    - Autodial support.

Refer to the *IBM AS/400 Licensed Program Installation Guide* for more information about this operating system.

IBM System/36 or 38 System Support Program (SSP)

The IBM System/36 or 38 System Support Program (S/36 or 38 SSP) is a disk-resident operating system that provides multiprogramming support. System/36 or 38 SSP provides these capabilities:

- Concurrent multiple interactive and batch job execution
- Virtual storage management techniques
- Disk data management that provides file sharing and protection for input, update, and add operations
- Security, which includes password sign-ons, multilevel data file, and multilevel library access
- System utilities for data file and library management
- Interactive Data Definition Utility (IDDU), data dictionary support
- System configuration utility to interactively define the configurations for:
  - Input/output devices
  - Local and remote workstations
  - Security
  - Performance options
  - Other IBM-supplied support
- Local and remote display and printer support
- Support for batch Binary Synchronous Communications (BSC)
- Support for Asynchronous Communications.

Interactive Communications Feature (SSP-ICF)

System/36 or 38 SSP-ICF is a set of programs that match the link and logical protocols of various host systems, subsystems, and terminals. System/36 or 38 SSP-ICF provides a common user interface that isolates the user from the link and logical protocols. Application programs and subsystems supported include:

- Binary Synchronous Communication subsystems for
  - CICS/OS/VS
  - CICS/DOS/VS
  - System/36 or 38
- SNA subsystems for
  - CICS
  - IMS/VS
  - System/36 or 38
- APPC support for mapped SNA LU 6.2 communications with a high-level interface
- Switched or non-switched point-to-point communication between a System/36 or 38 and an asynchronous device
- X.21 interface support to X.21 switched and non-switched networks
- Interactive terminal facility, to connect a System/36 or 38 to the services of a public data network.

Refer to the *IBM S/36 or 38, Setting Up Your Computer* manual for more information about this operating system.

IBM Series/1 Operating Systems

The IBM Series/1 lets you choose from two different operating systems, depending on your specific needs. Each operating system provides a complete environment for both application program development and application program execution. The two operating systems are:

- Realtime Programming System (RPS)
- Event-Driven Executive (EDX) — An ease-of-use oriented, storage-resident system.

The Series/1 Token-Ring Interface Program is used when attaching a Series/1 to an IBM Token-Ring Network. This program supports the EDX operating system but does not supports the RPS operating system

Refer to the *IBM Series/1 System Selection Guide* for detailed information about the EDX operating system.

Event-Driven Executive (EDX)

The Series/1 EDX operating system is an interactive, interpretive, response-oriented system appropriate for distributed processing and stand-alone environments. Language capabilities include COBOL, PL/1, Pascal, Assembler, FORTRAN IV, and Event-Driven Language. The EDX operating system has one basic facility.

Advanced Program-to-Program Communications

The EDX **Advanced Program-to-Program Communications** (APPC) facility supports the IBM APPC standard for LU 6.2 mapped and basic conversions as described in the *SNA Transactions Programmer's Reference Manual for LU Type 6.2* (GC30-3084). Application programs (written in any of the EDX-supported languages that have an EDL interface) may use the EDX APPC services to communicate with programs that also use their system's APPC services.

EDX Optional Features

The EDX operating system offers 10 optional features.

1 Communications Manager

The EDX **Communications Manager** feature is a licensed program providing functions that allow interactive message handling between the Series/1 and a variety of terminals, printers, and host computers. Highlights of the product include:

- Appearance of Series/1 displays and printers as 3270 Information Display stations to System/370 or System/390, 30XX, and 4300 host system and host application programs
- Series/1 support for downstream 3271 and BSC 3274 Control Units
- Series/1-to-Series/1 communications over a BSC line or over a local communications controller link

- Interfaces to other IBM systems or devices over a point-to-point BSC line
- Remote maintenance facilities
- Message routing with facilities to prioritize and queue messages
- Transaction processing facilities that include a scheduler and a high-speed loader
- Application development tools including a 3270 panel design aid
- Remote disk access.

2 Remote Manager

The EDX **Remote Manager** feature enables you to exchange data and information with the host communications and systems management programs via SNA sessions. This provides the Series/1 with a centralized management function using the following programs:

- Network Communications Control Facility
- Network Problem Determination Application
- Host Command Facility
- Distributed Systems Executive.

3 Systems Network Architecture Remote Job Entry

The EDX **Systems Network Architecture Remote Job Entry** feature allows the Series/1 to operate as an SNA remote job entry workstation, communicating with VTAM, TCAM, System/370 or System/390, 30xx, and 4300 database/data communications subsystems (IMS/VS or CICS/VS) application programs.

4 Indexed Access Method

The EDX **Indexed Access Method** feature provides data management capabilities that support indexed file operations. A single copy of the Indexed Access Method supports multiple programs and tasks sharing the same data files.

5 Sort/Merge

The EDX **Sort/Merge** feature lets you sort and merge records from up to eight input data sets into one output data set in either ascending or descending order. It can be initiated as a batch job or from a user routine in an application program.

6 Transaction Processing System

The EDX **Transaction Processing System** feature offers support for developing and managing transaction-oriented user application programs without the complexity of an operating system interface. Many application programs may be developed using the application program tools available.

7 Advanced Remote Job Entry

The EDX **Advanced Remote Job Entry** feature provides remote job entry workstation support for the Series/1 in an SNA or BSC environment.

8 X.25 High-Level Data Link Control Communications Support

The EDX **X.25 High-Level Data Link Control Communications Support** feature provides read/write level X.25/HDLC support for the DLC adapter and the SDLC single line control.

9 System/370 or System/390 Channel Attach

The EDX **System/370 or System/390 Channel Attach** feature and a Series/1 Channel Attach Device enable a Series/1 application program to communicate with a BTAM or BTAM-ES application program in a host computer, with the Series/1 responding as a locally attached IBM 3274 Control Unit.

10 Intelligent Workstation Support

The EDX **Intelligent Workstation Support** feature allows IBM PCs to be interconnected as a workstation to the Series/1, and through the Series/1 to the host.

Appendix A. Related Publications

Related Publications A-3
- LANs A-3
- IBM Cabling System A-3
- IBM Token-Ring Network A-3
- IBM PC Network A-4
- IBM LAN Hardware and Technical References A-5
- IBM Protocols, Interfaces, and Device Support A-6
- IBM Network Management A-6
- IBM Bridging Products A-8
- IBM Device Emulation, Servers, Gateways, and Remote Connections A-9
- IBM Workstations (Personal Computers and Personal System/2s) A-10
- IBM 9370 Information System A-11
- IBM 3174 Control Unit A-11
- IBM System/36 or 38 . . . . . A-11
- IBM Series/1 . . . . . A-12
- IBM AS/400 . . . . . A-12
- IBM 3720, 3725, and 3745 Communication Controllers A-12
- IBM Operating Systems and Subsystems A-13
- IBM SNA and Wide Area Networks A-14
- Additional Resources A-15

Related Publications

In addition to this *Administrator's Guide*, the network administrator may consult the following publications in performing LAN planning, installation, operation, software, and problem analysis and resolution activities. These publications may also list other publications related to or required for the products they describe.

You may obtain the items marked with an asterisk (*) from your IBM representative or branch office. Ask your IBM representative for information on purchasing the other manuals, kits, and program packages.

LANs

An Introduction to Local Area Networks, GC20-8203*

Discusses various LAN configurations and contains a description of the token-ring architecture.

IBM Cabling System

- *A Building Planning Guide for Communication Wiring*, G320-8059*

  Provides considerations for building planning based on both data and telecommunications needs.

- *IBM Cabling System Planning and Installation Guide*, GA27-3361*

  Describes how to plan for, document, and install the IBM Cabling System in your establishment.

- *IBM Cabling System Technical Interface Specification*, GA27-3773*

  For engineers and cable vendors; contains:

  - Specifications and characteristics of cables, components, and accessories used in the IBM Cabling System
  - Information necessary to manufacture, test, and install cables and components.

- *Using the IBM Cabling System with Communication Products*, GA27-3620*

  Describes how to use a number of IBM communication products with the IBM Cabling System.

IBM Token-Ring Network

- *IBM Token-Ring Network Architecture Reference*, SC30-3374*

  Describes in detail the architecture of the IBM Token-Ring Network, including the physical layer and the data link control layer: for use by product designers and developers, and system programmers.

- *IBM Token-Ring Network Guide for Small Networks*, SK2T-0300*

  Describes how to plan and install a network using IBM 8228 Multistation Access Units and patch cables in a building that does not have the IBM Cabling System installed.

- *IBM Token-Ring Network Installation Guide*, GA27-3678*

  Discusses the installation and cabling of IBM 8228 Multistation Access Units, IBM 8218 Copper Repeaters, IBM 8219 Optical Fiber Repeaters, and IBM 8220 Optical Fiber Converters. The manual also contains a chapter about solving problems in a newly installed network.

- *IBM Token-Ring Network Introduction and Planning Guide*, GA27-3677*

  Provides an overview of the IBM Token-Ring Network architecture and a description of the products used to build a network. Detailed planning instructions are provided, as well as a method for estimating ring utilization.

- *IBM Token-Ring Network Optical Fiber Cable Options*, GA27-3747*

  Describes test procedures used to qualify optical fiber cables other than IBM Cabling System type 5 optical fiber cable for use in the main ring path of an IBM Token-Ring Network.

- *IBM Token-Ring Network Problem Determination Guide*, SX27-3710*

  Details problem determination procedures used for locating and repairing problems in a network that has previously been operational.

- *IBM Token-Ring Network Starter Kit Guide*, SK2T-0303* (packaged with Installation Aid diskettes only; or in a kit with diskettes, programs, and hardware for a small ring)

  Contains instructions for assembling hardware and using the software Installation Aid to build a small ring of one access unit and up to four stations. One station is installed as a PC LAN Program server; the remaining stations are installed as users of the server. A demonstration is included to allow testing and immediate use of the ring.

- *IBM Token-Ring Network Technology*, GA27-3732*

  Contains 50 short papers written by members of the IBM Token-Ring Network development team, describing various aspects of the development process and capabilities of the network.

- *IBM Token-Ring Network Telephone Twisted-Pair Media Guide*, GA27-3714*

  Describes how to plan for the installation of a network that uses telephone twisted-pair wiring as its transmission medium. The manual also contains a Walk-Through Site Inspection Checklist to help the user determine the suitability of using telephone twisted-pair wiring for Token-Ring Network transmission at a site.

IBM PC Network

- *IBM PC Network Baseband Planning Guide*, S68X-2268*

  Provides information necessary for the planning and installation of the IBM PC Network Baseband using baseband network components and cables.

- *IBM PC Network Broadband Planning Guide*, S68X-2269*

  Provides information necessary for the planning and installation of the broadband IBM PC Network.

- *Technical Reference* manuals for IBM PC Network adapters

  Provide technical information for using IBM PC Network adapters including programming considerations, interface information and specifications, and Remote Program Load.

IBM LAN Hardware and Technical References

- *IBM PC Network Baseband Extender Technical Reference*, S68X-2266*

  Describes the functions, circuitry, network interface, and electrical specifications for the IBM PC Network Baseband Extender.

- *Remote Program Load User's Guide*, (packaged with an RPL adapter module and a diskette) describes

  - Basic principles involved in using RPL on an IBM Token-Ring Network to load programs from one network station into the memory of another network station, without using a disk or diskette drive on the receiving computer
  - The RPL kit and what is needed to use it
  - Installation of the RPL module on the network adapter
  - The programs that are required to use RPL on the IBM Token-Ring Network
  - RPL problem determination information.

- *Guide to Operations* manuals for IBM Token-Ring Network adapters used in the personal computers with PC/IO channel architecture (packaged with adapter and diskette)

  Describes the installation and operation of the adapters. Explains the use of the Adapter Diagnostics, included on the diskette, to test the operation of the adapter.

- *IBM RT PC Technical Reference Token-Ring Network Adapter*, SK2T-0291*

  Describes the operating characteristics of the IBM Token-Ring Network RT PC Adapter. This is a reference publication intended for hardware and program designers, programmers, engineers, and anyone else who needs to understand the design and operation of the IBM Token-Ring Network RT PC Adapter. Includes information on functions and features, the hardware and its operation, software necessary for adapter utilization, and environmental requirements to ensure proper operation.

- *IBM Local Area Network Technical Reference*, SC30-3383*

  Provides information for using the IBM Token-Ring Network adapters and supporting routines in the appropriate IBM computer, and aiding in producing a network adapter card for use in an IBM computer. For the IBM Token-Ring Network and the IBM PC Network, the manual provides information for preparing programs and using the adapters in IBM-compatible devices.

- *IBM Token-Ring Network PC Adapter Hardware Maintenance and Service* (packaged with diskette and wrap plug)

  Provides Advanced Diagnostics to check the IBM Token-Ring Network PC Adapter, Adapter II, and adapter cable.

- *Installation and Testing Instructions* for IBM Token-Ring Network adapters used in personal computers with Micro Channel architecture (packaged with adapter and diskette)

  Explains how to install, test the operation of, and resolve problems with the adapters.

- *Installation Instructions* for IBM PC Network Broadband adapters and IBM PC Network Baseband adapters used in IBM PCs (packaged with adapter)

  Explains how to install the adapters.

- *IBM PC Network Adapter Hardware Maintenance and Service* (packaged with diskette)

  Provides Diagnostics to check the IBM PC Network adapters.

IBM Protocols, Interfaces, and Device Support

- *IBM LAN Channel Support Program User's Guide*, SC30-3458* (packaged with program diskette, or available separately)

  Explains how to install and use the IBM LAN Channel Support Program on the IBM 8232 LAN Channel Station. This program enables a workstation on a LAN to communicate with a host computer when both the workstation and the host computer have the IBM Transmission Control Protocol/Internet Protocol (TCP/IP) Program installed.

- *IBM Advanced Program-to-Program Communication for the IBM Personal Computer (APPC/PC) Installation and Configuration Guide* (packaged with program diskette)

  Describes installation, configuration, and problem resolution for APPC/PC.

- *IBM Advanced Program-to-Program Communication for the IBM Personal Computer (APPC/PC) Programming Guide*

  Describes how to develop application programs that use the APPC/PC Application Program Interface to communicate on a network.

- *IBM Local Area Network Support Program User's Guide* (packaged with a program diskette)

  Describes the use of configuration parameters and code modules to provide adapter support and NETBIOS interface support for IBM Token-Ring Network and IBM PC Network adapters.

IBM Network Management

- *IBM LAN Manager User's Guide* (packaged with program diskettes)

  Explains how to install the IBM LAN Manager program and use its functions for network management, administration, and problem resolution. Contains information on:

  - Network problem determination
  - Communication with IBM bridge programs
  - Generation of alerts and their use on the network and at an attached host

- *IBM LAN Manager Version 2 User's Guide* (packaged with program diskettes)

  Explains how to install the IBM LAN Manager program Version 2.0 and use its functions for network management, administration, and problem resolution. Contains information on:

  - Network problem determination
  - Communication with IBM bridge programs
  - Generation of alerts and their use on the network and at an attached host

- *IBM Token-Ring Network Manager User's Guide* Version 1.1 (packaged with program and tutorial diskettes)

  Explains how to install and use the IBM Token-Ring Network Manager program for network management, administration, and problem determination. The Network Manager can run either stand-alone on the network, or as an application of NetView/PC for communication of network alerts to a host.

  The tutorial introduces the user to the IBM Token-Ring Network Manager and the IBM Token-Ring Network.

- *IBM Token-Ring Network Trace and Performance Program User's Guide* (packaged with program diskettes)

  Explains how to install and use the Trace and Performance Program, which includes facilities to:

  - Trace the frames sent over a single ring (by frame type, source address, destination address, or combinations thereof)
  - Analyze, summarize, and display the information gathered by the trace facility
  - Collect frame and byte count statistics on a single ring, and display either the current ring utilization or ring utilization history over a specified period of time (by frame type, source address, destination address, or combinations thereof)
  - Analyze and summarize count and utilization statistics in bar graph or tabular form

- *IBM PC 3270 Emulation LAN Management Program User's Guide* (packaged with program diskettes)

  Explains how to install the IBM PC 3270 Emulation Local Area Network Management Program in a computer with the IBM PC 3270 Emulation Program configured as a gateway to a host. The IBM PC 3270 Emulation Local Area Network Management Program monitors the LAN to which it is connected, and sends alerts for network error conditions through the gateway to a host NetView console.

- *IBM LAN Manager Entry User's Guide* (packaged with program diskettes)

  Explains how to install the IBM LAN Manager Entry Program. The IBM LAN Manager Entry Program monitors the LAN to which it is connected, sends alerts for network error conditions through a gateway to a host NetView console, and responds to SPCS commands from the NetView operator.

- *IBM Local Area Network Host Information*, SC30-3479*

  Explains the meaning of each alert generated by:

  - The IBM PC 3270 Emulation LAN Management Program
  - The IBM LAN Manager Programs

  The alerts are sent to a host computer NetView console through a link established between the host and a station on the LAN where the alerts originated.

  The manual also describes additional information about the recommended actions for resolving the problems or conditions indicated by the alerts. The additional information guides the network administrator and those resolving problems in the use of NetView information to:

  - Locate the cause of a condition or problem
  - Identify the resources, tools, and procedures required to isolate and resolve the problem or condition

- *NetView: Learning about NetView Release 2*, SK2T-0292* (packaged with program diskettes)

  Contains an online tutorial that uses graphics, animation, and NetView screen simulations to introduce SNA network management using the NetView Program.

- *IBM NetView Operation Guide*, SC31-6019*

  Contains information about using NetView.

- *IBM NetView/PC Operation Guide*, SC31-6003*

  Contains information about using NetView/PC.

IBM Bridging Products

- *IBM Token-Ring Network Bridge Program User's Guide* (packaged with program diskettes)

  Describes the installation, configuration, and operation of the Bridge Program. Also included are message explanations and procedures for problem resolution. This *Administrator's Guide* is referenced for specific information on setting certain configuration parameters and for verifying the operation of a multi-segment network.

- *IBM PC Network Bridge Program User's Guide* (packaged with program diskettes)

  Describes the installation, configuration, and operation of the Bridge Program. Also included are message explanations and procedures for problem resolution. This *Administrator's Guide* is referenced for specific information on setting certain configuration parameters and for verifying the operation of a multi-segment network.

- *IBM Token-Ring Network/PC Network Interconnect User's Guide* (packaged with program diskette)

  Describes installation, configuration, and operation of the Interconnect. The Interconnect joins either an IBM PC Network and an IBM Token-Ring Network or two IBM PC Networks, allowing programs that use the NETBIOS interface on one network to communicate with similar programs on the other network.

- *IBM 8209 LAN Bridge Customer Information*, SA21-9994-01

  Contains a description of IBM 8209 functions and instructions for installing the IBM 8209.

- *IBM 8209 LAN Bridge Service Information*, SY31-9077-01

  Contains instructions and procedures for trained service persons to use to identify and replace malfunctioning IBM 8209 hardware components.

- *IBM 8209 LAN Bridge Attachment Module Guide for Ethernet and IEEE 802.3 LANs*, GA27-3891

  Contains instructions for installing the Ethernet attachment module in the IBM 8209, for setting attachment module switches for basic configuration, and for using the Utility Program to do IBM 8209 advanced configuration. IBM 8209 functions and configuration parameters are described.

- *IBM 8209 LAN Bridge Attachment Module Guide for the IBM Token-Ring Network*, GA27-3915

  Contains instructions for installing the token-ring attachment module in the IBM 8209, for setting attachment module switches for basic configuration, and for using the Utility Program to do IBM 8209 advanced configuration. IBM 8209 functions and configuration parameters are described.

IBM Device Emulation, Servers, Gateways, and Remote Connections

- *IBM 3270 Workstation Program Version 1.10 Setup and Customization* (packaged with program diskette)

- *IBM PC LAN Program Version 1.3 Getting Started: Installation and Configuration* (packaged with a program diskette)

- *IBM PC LAN Program Version 1.3 Reference* (packaged with program diskette)

- *IBM PC Local Area Network (LAN) Program User's Guide* (packaged with program diskettes)

  Describes use, operation, and problem resolution for the IBM PC LAN Program. The PC LAN Program provides message and server functions to IBM PC Network and IBM Token-Ring Network users.

- *IBM PC 3270 Emulation Program User's Guide* (packaged with program diskettes)

  Explains how to install and use the IBM PC 3270 Emulation Program to:

  - Cause a personal computer on a LAN to appear to operate as a 3270-type terminal

  - Provide a gateway connection to an SNA host computer

- *IBM Asynchronous Communications Server Program Installation and Configuration Guide*, SC30-3364 (packaged with program diskettes)

  Serves as a guide and reference for the IBM Asynchronous Communications Server Program. A basic reference for system administrators, designers, and installers, this manual contains the information and step-by-step instructions needed to plan, install, and configure the program and assist in problem solving.

- *IBM Local Area Network Asynchronous Connection Server (LANACS) Program Installation and Configuration Guide* (packaged with program diskettes)

  Explains how to:

  - Install the program
  - Configure or reconfigure the server
  - Resolve problems with the program, the configuration, and the server

- *IBM Remote NETBIOS Access Facility Program, Version 2.1, Installation and Configuration Guide*, SK2T-0323* (packaged with program diskettes)

  Explains how to plan for, install, configure and identify and resolve possible problems with the IBM Remote NETBIOS Access Facility Program.

- *IBM LAN to LAN Wide Area Network Program User's Guide* (packaged with program diskettes)

  Explains how to:

  - Install the program
  - Configure the LTLW
  - Operate the LTLW
  - Resolve problems with the LTLW.

IBM Workstations (Personal Computers and Personal System/2s)

- *Guide to Operations* for IBM Personal Computer models

  Describes installation of options, operating procedures, and safety considerations for IBM PCs.

- *Quick Reference* manuals for IBM PS/2 computers

  Describe installation of options, operating procedures, and preparation and use of a Reference Diskette for running hardware diagnostics on the computer and installed options.

- *IBM Personal Computer Hardware Maintenance and Service*, S68X-2240

  Describes how to run Advanced Diagnostics to diagnose computer components or installed options that are not functioning properly, and how to replace the components or options if necessary.

- *IBM Personal System/2 Hardware Maintenance Reference*

  Contains a section that describes to trained service personnel how to run Advanced Diagnostics to diagnose an IBM Token-Ring Network Adapter/A or adapter cable that is not functioning properly, and to replace the adapter or cable if necessary.

  Also contains a section that describes testing, error messages, problem determination, and replacement for the IBM Token-Ring Network Adapter/A Remote Program Load module.

- *IBM Personal System/2 Hardware Maintenance Service*

  Contains Maintenance Analysis Procedures (MAPs), a Parts Catalog, and a section that describes Adapter/A error messages.

  Also contains a Parts Catalog for the IBM Token-Ring Network Adapter/A Remote Program Load module.

Notes:

1. The Adapter/A Service and Reference sections are packaged as an *IBM Token-Ring Network Adapter/A Supplement*, also containing a diskette and a wrap plug.
2. The Adapter/A Remote Program Load Reference and Service sections are packaged as an *IBM Token-Ring Network Adapter/A Remote Program Load Supplement*.

IBM 9370 Information System

- *IBM 9370 Information System: Token-Ring Subsystem Description*, SA09-1739*

  Introduces the IBM Token-Ring Subsystem and describes its compliance to Institute of Electrical and Electronics Engineers (IEEE) standards. The layers of connectivity, the channel access protocol, and the Ring Error Monitor are described along with their functions. This manual provides information for those who require an overview of the Support Programs which allows an IBM 9370 Information System to connect to an IBM Token-Ring Network.
- *IBM ES/9370 Installing the System*, SA24-4033*
- *IBM ES/9370 Using the System Programmer Function*, SA24-4037*
- *IBM 9370 Information System, Using the Token-Ring Subsystem*, SA09-1738*
- *IBM VM/SP TSAF 9370 Local Area Network Subsystems*, GC24-5363*

IBM 3174 Control Unit

- *IBM 3270 Information Display System 3174 Subsystem Control Unit Customizing Guide*, GA23-0214*
- *IBM 3270 Information Display System 3174 Subsystem Control Unit Functional Description*, GA23-0218*

IBM System/36 or 38

- *IBM S/36 or 38 Setting Up Your Computer*, SA21-9430*
- *IBM 5362 Installing Your New Features*, SA21-9486*
- *IBM S/36 or 38 Changing Your System Configuration*, SC21-9052*
- *IBM S/36 or 38 Local Area Network Attachment Guide to Operations*, SA21-9911*
- *IBM S/36 or 38 PC Support/36 or 38 User's Guide*, SC21-9088*
- *IBM PC Support/36 or 38 Workstation Feature Version 1 User's Guide*, SC21-9564*
- *IBM S/36 or 38 Using S/36 or 38 Communications*, SC21-9082*
- *IBM S/36 or 38 Interactive Communications Feature: Base Subsystems Reference*, SC21-9530*
- *IBM S/36 or 38 Interactive Communications Feature: Features and Examples Guide*, SC21-7911*
- *IBM System/36 or 38 Distributed Data Management (DDM) Guide 5727-SS1 Feature Number 6037*, SC21-8011*
- *IBM S/36 or 38 Local Area Network Attachment Hardware Maintenance and Service*, SY31-9050*

IBM Series/1

- *IBM Series/1 Digest*, G360-0061*

  This publication presents a comprehensive view of the Series/1 computing family, its programming, and support services.

- *IBM Series/1 System Selection Guide*, GA34-0143*

  This publication includes a brief comparison of two operating systems for the Series/1 and configuration examples.

- *IBM Series/1 Pocket Digest*, GX34-0104*
- *IBM Series/1 Customer Site Preparation Manual*, GA34-0050*
- *IBM Series/1 Realtime Programming System Version 7: Concepts and Facilities*, GC34-0614*
- *IBM Series/1 Event Driven Executive Library Guide and Common Index*, SC34-0645*

IBM AS/400

- *IBM AS/400 Licensed Program Installation Guide*, SC21-9765*
- *IBM AS/400 PC Support Installation Guide*, SC21-8089*
- *IBM AS/400 PC Support: Operations Reference*, SC21-8090*
- *IBM AS/400 PC Support: Technical Reference*, SC21-8091*
- *IBM AS/400 PC Support: User's Guide*, SC21-8092*
- *IBM AS/400 Communications User's Guide*, SC21-9601*
- *IBM AS/400: S/36 or 38 to AS/400 Migration Aid User's Guide Reference*, SC09-1166*
- *IBM AS/400 Communications: APPN User's Guide*, SC21-9598*
- *IBM AS/400 Communications: Communications and Systems Management User's Guide*, SC21-9661*
- *IBM AS/400 Communications: Programmer's Guide*, SC21-9590*
- *IBM AS/400 Communications: 3270 Device Emulation User's Guide*, SC21-9602*
- *IBM AS/400 System Operations: Operator's Guide*, SC21-8082*

IBM 3720, 3725, and 3745 Communication Controllers

- *IBM 3720/3721 Communication Controller Configuration Guide*, GA33-0063*
- *IBM 3725 Model 1 Communication Controller: Configuration Guide*, SA33-0012*
- *IBM 3725 Model 2 Communication Controller: Configuration Guide*, SA33-0022*
- *IBM 3745 Configuration Guide*, GA33-0093*

IBM Operating Systems and Subsystems

IBM VM/SP

- *IBM VM/SP Transparent Services Access Facility Reference*, SC24-5287*
- *IBM VM/SP Planning Guide and Reference*, SC19-6201*
- *IBM VM/SP TSAF 9370 Local Area Network Subsystems*, GC24-5363*

IBM PC DOS

- *IBM PC DOS User's Guide*

  Provides step-by-step instructions for starting to use PC DOS and for using the most frequently used commands to do simple tasks. (Does not explain using the /S option of the FORMAT command to format a system disk or diskette; see the *PC DOS Reference*.)

- *IBM PC DOS Reference*

  Describes in detail PC DOS commands, functions, and messages.

- *IBM Disk Operating System Technical Reference*

  Describes DOS technical advantages, programming considerations, and programming characteristics for developing DOS application programs.

IBM OS/2

- *IBM Operating System/2 Extended Edition Command Reference*
- *IBM Operating System/2 Extended Edition User's Guide*
- *IBM Operating System/2 Extended Edition System Administrator's Guide for Communications*

IBM AIX

AIX Manuals are packaged with individual AIX products and available separately.

- IBM AIX PS/2 Operating System Library, SBOF-1831*
- *IBM AIX PS/2 General Information Manual*, GC23-2055*
- IBM AIX PS/2 Operating System Extensions Library, SBOF-1833*
- *IBM AIX PS/2 DOS Merge User's Guide*, SC23-2045*
- *IBM AIX PS/2 Workstation Host Interface Program User's Guide and Reference*, SC23-2060*
- *IBM AIX PS/2 Interface Program for Use with TCP/IP*, SC23-2047*
- *IBM AIX/370 Library Overview*, SC23-2063*
- *IBM AIX/370 Planning Guide*, SC23-2064*
- *IBM AIX/370 Administration Guide*, SC23-2088*
- *IBM AIX/370 Transmission Control Protocol/Internet Protocol (TCP/IP)*, SC23-2084*
- *IBM AIX/370 Library Overview*, SC23-2063*

IBM SNA and Wide Area Networks

- *IBM ACF/VTAM Version 3 Installation and Resource Definition*, SC23-0111*
- *IBM Network Control Program System Support Program Emulation Program V5 Resource Definition Guide*, SC30-3447*
- *IBM Network Control Program System Support Program Emulation Program V5 Resource Definition Reference*, SC30-3448*
- *IBM NCP Resource Definition Guide*, SC30-3349*
- *IBM ACF/NCP/SSP Version 3 Resource Definition Reference*, SC30-3254*
- *IBM Systems Network Architecture: Technical Overview*, GC30-3073*

  This manual provides a technical overview of IBM's Systems Network Architecture (SNA). It explains SNA functions provided and how they provide communication between network users. This is a basic publication for system programmers and other data processing personnel responsible for defining SNA networks.

- *IBM Network Program Products: Bibliography and Master Index*, GC30-3353*

  This manual aids users of IBM network programs in finding and using information in product libraries. It contains a bibliography, glossary, and master index for the following licensed programs:

  - NetView
  - NetView/PC
  - ACF/VTAM
  - ACF/NCP
  - ACF/SSP

- *IBM Network Program Products: General Information: MVS, VM, VSE*, GC30-3350*

  This manual is designed for system planners and data processing managers responsible for evaluating programs to be used in their network. It describes the services obtainable from a telecommunication network operating with the following IBM licensed programs:

  - ACF/VTAM
  - ACF/NCP
  - ACF/SSP
  - NetView.

Additional Resources

Supplemental Publications: The following publications provide insight, from testing and experience, in the use of LAN products and in the relationships between products. These publications supplement, but **do not replace**, the information supplied with the products.

- *IBM 3725 Network Control Program Token-Ring Interface Planning and Implementation*, GG24-3110*
- *IBM Token-Ring Network PC Products Description and Installation*, GC24-1739*
- *Local Area Networks: Concepts and Positioning*, GG24-3178*
- *IBM Token-Ring Network and Network Basic Input/Output Systems Applications*, GG24-1737*
- *IBM S/36 or 38 Token-Ring Attachment In An Intelligent Workstation Environment*, GG24-3207*
- *IBM System/36 or 38 Advanced Program-to-Program Communications Implementation Guide*, GG24-1693*
- *Introduction to Programming for APPC/PC*, GG24-3034*
- *Introduction to Advanced Program-to-Program Communications*, GG24-1584*
- *Experiences of Connecting APPC/PC and CICS/VS with the IBM 3174 Token-Ring Network Gateway Feature*, GG66-0287*
- *Guidelines For Setting IBM Local Area Network (LAN) Support Program Parameters for use with Selected IBM Products*, GG22-9430*
- *IBM PC Network and Network Basic Input/Output Systems Applications*, GG24-1737*
- *IBM Advanced Communications Function Products Installation Guide*, GG24-1557*
- *IBM Local Area Network Asynchronous Connection Server (LANACS) Configuration Samples, Tips and Techniques*, GG22-9425*
- *IBM 9370 Installation Hints and Tips*, GG24-1544*
- *IBM 9370 LAN Volume 1: Token-Ring Support*, GG24-3240*
- *IBM 9370 LAN Volume 2: IEEE 802.3 Support*, GG24-3227*
- *IBM 3174 Subsystem Control Unit Installation Guide*, GG24-3061*
- *IBM 3745 Communication Controller Guide*, GG24-1562*
- *IBM 3720 Communication Controller Guide*, GG24-3098*
- *IBM Transmission Control Protocol/Internet Protocol for VM; Installation and Maintenance*, GC09-1203*

Systems Application Architecture

- *IBM Systems Application Architecture: An Overview*, GC26-4341*

  Contains information necessary for managers and technical personnel to evaluate IBM's Systems Application Architecture and do preliminary, high-level planning for its implementation.

- *IBM Systems Application Architecture: Writing Applications: A Design Guide*, SC26-4362*

  Discusses for a broad audience the need for application program portability, how IBM's Systems Application Architecture (SAA) addresses portability, and offers guidance on enhancing the portability and use of application programs:

  - Explains how application program portability and SAA can help information management services be more efficient and responsive
  - Describes how SAA serves as a foundation for attaining the portability that will extend the life of application programs and increase programmer productivity
  - Identifies SAA components and the design and programming techniques that can be used to create portable application programs

- *IBM Systems Application Architecture: Common User Access: Panel Design and User Interaction*, SC26-4351*

  Primarily for application program designers and developers, this manual defines and describes the IBM end-user interface and Common User Access so portable application programs can be created to run on System/370 or System/390, System/3X, and IBM PCs.

Appendix B. Bridge Performance Analysis Worksheets

Bridge Performance Analysis Worksheets B-3
Bridge Performance Analysis Worksheets for the IBM LAN Manager B-13
Bridge Performance Analysis Worksheets for the IBM LAN Network Manager B-21
Bridge Performance Analysis Calculations Worksheets B-27

Table B-1 indicates which worksheet to use with each version of the bridge programs, the IBM LAN Manager, and the IBM LAN Network Manager.

Note: The IBM LAN Manager or IBM LAN Network Manager Worksheets are used for the IBM 8209 LAN Bridge.

Table B-1. Selecting the Proper Bridge Performance Analysis Worksheet

Worksheet	IBM Token-Ring Network Bridge Program	IBM PC Network Bridge Program	IBM LAN Manager	IBM LAN Network Manager
Bridge Performance Analysis Worksheet	V1.1, V2.0			
Bridge Performance Analysis Worksheet (Using the Local Bridge Function)	V2.1, V2.2			
Bridge Performance Analysis Worksheet (Using the Remote Bridge Function)	V2.1, V2.2			
Bridge Performance Analysis Worksheet for the IBM PC Network Bridge Program		V1.0	V2.0	V1.0
Bridge Performance Analysis Worksheet for the IBM LAN Manager			V1.0, V2.0	
Remote Bridge Performance Analysis Worksheet for the IBM LAN Manager V2.0			V2.0	
Bridge Performance Analysis Worksheet for the IBM LAN Network Manager				V1.0
Remote Bridge Performance Analysis Worksheet for the IBM LAN Network Manager 1.0				V1.0
Bridge Performance Analysis Calculations Worksheet	V1.1, V2.0		V1.0, V2.0	V1.0
Bridge Performance Analysis Calculations Worksheet (Using the Local Bridge Function)	V2.1, V2.2-Local		V1.0, V2.0	V1.0
Remote Bridge Performance Analysis Calculations Worksheet	V2.1, V2.2-Remote		V2.0	V1.0
Bridge Performance Analysis Calculations Worksheet for the IBM PC Network Bridge Program		V1.0		

Bridge Performance Analysis Worksheets

The Bridge Performance Analysis worksheets are used at bridge stations to record bridge performance counter values for one measurement period. Be sure to provide the appropriate worksheet from this appendix or from the appropriate bridge program *User's Guide*:

- The **Bridge Performance Analysis Worksheet** is for use with the IBM Token-Ring Network Bridge Program Versions 1.1 and 2.0.
- The **Bridge Performance Analysis Worksheet (Using the Local Bridge Function)** is for use with the IBM Token-Ring Network Bridge Program Version 2.1 and Version 2.2 using the local bridge function.
- The **Bridge Performance Analysis Worksheet (Using the Remote Bridge Function)** is for use with the IBM Token-Ring Network Bridge Program Version 2.1 and Version 2.2 using the remote bridge function.
- The **Bridge Performance Analysis Worksheet for the IBM PC Network Bridge Program** is for use with the IBM PC Network Bridge Program.

The counter values recorded on these worksheets are used in the computations shown on the Bridge Performance Analysis Calculations worksheets. Each counter value is identified by a descriptor (A1, for example). These descriptors identify the counter values to use in the computations. The descriptors do not appear on the Bridge Program Performance Counters panel.

To use the Bridge Performance Analysis worksheets:

1. Select the worksheet for the bridge program, and function (local or remote) if applicable, being evaluated. Make at least one copy of the blank original worksheet. Save the original to copy again later.
2. At the bridge station, select "Configuration Data" from the Main Menu.
3. On a copy of the worksheet:
   - Record the Bridge Program Level shown on the Configuration Data panel.
   - Fill in the Bridge Name or Number. You can use the Bridge Number and LAN Segment Number, or some other name or identifier that will identify this bridge to you during your bridge traffic evaluation.
4. Determine the length of time for the measurement period.
5. Return to the Bridge Program Main Menu and select "Performance Counters."
6. When the Performance Counters panel is displayed, press **F9 (Reset)** to clear the performance counters to zeros. (Pressing **F9** will not affect the performance counters accessible from the IBM LAN Manager or those used for the Performance Statistics.)

7 Wait until the desired measurement period has elapsed.

You may use other Bridge Program functions during the measurement period.

If the message "ECCBR189W Performance counters have overflowed, press reset to clear them" is displayed during the measurement period, the measurement will be in error. Return to step 6 on page B-3 and use a shorter measurement period.

8 At the end of the desired measurement period, display the Performance Counters panel again.

If you were using another Bridge Program function, return to the Performance Counters panel from the Main Menu.

If no other Bridge Program function was used and the Performance Counters panel is still displayed, press **F5 (Refresh)** to update the panel information to the current performance counter values and time of day.

9 On the copy of the Bridge Performance Analysis Worksheet, record the date and time of day the counters were reset to zeros, the date and time of day the counters were refreshed, and the performance counter values.

The times are displayed and should be recorded on the worksheet in the format HH:MM:SS, where H = hour, M = minute, and S = second. (08:35:20 means 35 minutes and 20 seconds after 8 o'clock.)

10 Add the counter values for the two LAN segments to obtain and record the bridge totals.

11 Give the completed worksheet to your network administrator or to the person who will use the Bridge Performance Analysis Calculations Worksheets.

Bridge Performance Analysis Worksheet

(Use with the IBM Token-Ring Network Bridge Program Versions 1.1 and 2.0)

Date ______________

Bridge Name or Number ______________

Bridge Program Level ______________

LAN Segment Types ______________ ______________

At the bridge computer:

1. **Display the first Configuration Data panel.**
2. **Record the Bridge Program Level and LAN Segment Types on the worksheet.**
3. **Display the Bridge Program Performance Counters panel.**
4. **Press F9 (Reset) to clear the counters.**
5. **Wait _______ minutes.**
6. **Refresh (press F5) or display the counters again.**
7. **In the spaces provided below, write the information from the panel.**
8. **Add the values for each LAN segment to obtain each Bridge Total.**

Counters reset on ____- ____ - ____ at ____ : ____ : ____

Counters refreshed on ____- ____ - ____ at ____ : ____ : ____

Frames Forwarded Values for:

	LAN Segment ________	**+ LAN Segment** ________	**= Bridge Total**
Broadcast frames	**(A1)** ____________________	+ **(A2)** ____________________	= **(A3)** ________________
Broadcast bytes	**(B1)** ____________________	+ **(B2)** ____________________	= **(B3)** ________________
Non-broadcast frames	**(C1)** ____________________	+ **(C2)** ____________________	= **(C3)** ________________
Non-broadcast bytes	**(D1)** ____________________	+ **(D2)** ____________________	= **(D3)** ________________

Frames Not Forwarded Because:

	LAN Segment ________	**+ LAN Segment** ________	**= Bridge Total**
Target LAN segment inoperative	**(E1)** ____________________	+ **(E2)** ____________________	= **(E3)** ________________
Adapter congestion	**(F1)** ____________________	+ **(F2)** ____________________	= **(F3)** ________________
Other reasons	**(G1)** ____________________	+ **(G2)** ____________________	= **(G3)** ________________

Bridge Performance Analysis Worksheet
(Using the Local Bridge Function)

(Use with the IBM Token-Ring Network Bridge Program Versions 2.1 and 2.2)

Date ______________

Bridge Name or Number ______________

Bridge Program Level ______________

LAN Segment Types ______________ ______________

At the bridge computer:

1. **Display the first Configuration Data panel.**
2. **Record the Bridge Program Level and LAN Segment Types on the worksheet.**
3. **Display the Bridge Program Performance Counters panel.**
4. **Press F9 (Reset) to clear the counters.**
5. **Wait ___ minutes.**
6. **Refresh (press F5) or display the counters again.**
7. **In the spaces provided below, write the information from the panel.**
8. **Add the values for each LAN segment to obtain each Bridge Total.**

Counters reset on ___- ___ - ___ at ___ : ___ : ___

Counters refreshed on ___- ___ - ___ at ___ : ___ : ___

Frames Forwarded Values for:

	LAN Segment ________	.+ LAN Segment ________	= Bridge Total
Broadcast frames	(A1) ____________	+ (A2) ____________	= (A3) ____________
Broadcast bytes	(B1) ____________	+ (B2) ____________	= (B3) ____________
Non-broadcast frames	(C1) ____________	+ (C2) ____________	= (C3) ____________
Non-broadcast bytes	(D1) ____________	+ (D2) ____________	= (D3) ____________

Frames Not Forwarded Because:

	LAN Segment ________	.+ LAN Segment ________	= Bridge Total
Target LAN segment inoperative	(E1) ____________	+ (E2) ____________	= (E3) ____________
Adapter congestion	(F1) ____________	+ (F2) ____________	= (F3) ____________
Filtered	(G1) ____________	+ (G2) ____________	= (G3) ____________
Other reasons	(H1) ____________	+ (H2) ____________	= (H3) ____________

Bridge Performance Analysis Worksheet
(Using the Remote Bridge Function)

(Use with the IBM Token-Ring Network Bridge Program Versions 2.1 and 2.2)

Date ______________

Bridge Name or Number ______________

Bridge Program Level ______________

LAN Segment Types ______________ ______________

At the bridge computer:

1. **Display the first Configuration Data panel.**
2. **Record the Bridge Program Level and LAN Segment Types on the worksheet.**
3. **Display the Bridge Program Performance Counters panel.**
4. **Press F9 (Reset) to clear the counters.**
5. **Wait _______ minutes.**
6. **Refresh (press F5) or display the counters again.**
7. **In the spaces provided below, write the information from the panel.**
8. **Add the values for each LAN segment to obtain each Bridge Total.**

Counters reset on ___- ___ - ___ at ___ : ___ : ___

Counters refreshed on ___- ___ - ___ at ___ : ___ : ___

Frames Forwarded Values for:

	LAN Segment ________	+ LAN Segment ________	= Bridge Total
Broadcast frames	(Q1) ____________	+ (Q2) ____________	= (Q3) ____________
Broadcast bytes	(R1) ____________	+ (R2) ____________	= (R3) ____________
Non-broadcast frames	(S1) ____________	+ (S2) ____________	= (S3) ____________
Non-broadcast bytes	(T1) ____________	+ (T2) ____________	= (T3) ____________

Frames Not Forwarded Because:

	LAN Segment ________	+ LAN Segment ________	= Bridge Total
Target LAN segment inoperative	(U1) ____________	+ (U2) ____________	= (U3) ____________
Adapter congestion	(V1) ____________	+ (V2) ____________	= (V3) ____________
Telecommunications link error (frames)	(W1) ____________	+ (W2) ____________	= (W3) ____________
Telecommunications link error (bytes)	(X1) ____________	+ (X2) ____________	= (X3) ____________
Filtered	(Y1) ____________	+ (Y2) ____________	= (Y3) ____________
Other reasons	(Z1) ____________	+ (Z2) ____________	= (Z3) ____________

Bridge Performance Analysis Worksheet for the IBM PC Network Bridge Program

Date ____________

Bridge Name or Number ____________

Bridge Program Level ____________

LAN Segment Types ____________ ____________

At the bridge computer:

1. **Display the first Configuration Data panel.**
2. **Record the Bridge Program Level and LAN Segment Types on the worksheet.**
3. **Display the Bridge Program Performance Counters panel.**
4. **Press F9 (Reset) to clear the counters.**
5. **Wait ______ minutes.**
6. **Refresh (press F5) or display the counters again.**
7. **In the spaces provided below, write the information from the panel.**
8. **Add the values for each LAN segment to obtain each Bridge Total.**

Counters reset on ___-___-___ at ___:___:___

Counters refreshed on ___-___-___ at ___:___:___

Frames Forwarded Values for:

	LAN Segment ______	+ LAN Segment ______	= Bridge Total
Broadcast frames	(A1) ____________	+ (A2) ____________	= (A3) ____________
Broadcast bytes	(B1) ____________	+ (B2) ____________	= (B3) ____________
Non-broadcast frames	(C1) ____________	+ (C2) ____________	= (C3) ____________
Non-broadcast bytes	(D1) ____________	+ (D2) ____________	= (D3) ____________

Frames Not Forwarded Because:

	LAN Segment ______	+ LAN Segment ______	= Bridge Total
Target LAN segment inoperative	(E1) ____________	+ (E2) ____________	= (E3) ____________
Adapter congestion	(F1) ____________	+ (F2) ____________	= (F3) ____________
Other reasons	(G1) ____________	+ (G2) ____________	= (G3) ____________

Other Frames Processed by the Bridge:

	LAN Segment ______	+ LAN Segment ______	= Bridge Total
Frames not routed across this bridge	(H1) ____________	+ (H2) ____________	= (H3) ____________

Bridge Performance Analysis Worksheets for the IBM LAN Manager

The Bridge Performance Analysis worksheets for the IBM LAN Manager are used at IBM LAN Manager stations to record performance counter values accumulated by one bridge during one measurement period.

- Use the **Bridge Performance Analysis Worksheet for the IBM LAN Manager** at an IBM LAN Manager station for the IBM 8209 LAN Bridge and for all bridge programs except those using the remote bridge function. (See Table B-1 on page B-1.)

  Notes:

  1. For the IBM PC Network Bridge Program, the "Frames Not Routed Across This Bridge" counter does not appear on the IBM LAN Manager Bridge Performance Counters panel or in the IBM LAN Manager Version 2.0 counter file data records. If you want to include this counter in analysis calculations, you must obtain the counter values at the bridge station. You may be able to obtain adequate approximations in the calculations that use this counter (the ones involving adapter congestion) by assuming a counter value of zero in the calculations. A more exact result requires obtaining actual counter values.
  2. For the IBM Token-Ring Network Bridge Program Version 2.1, the "Frames not forwarded, Filtered" counter does not appear on the IBM LAN Manager Bridge Performance Counters panel or in the counter file. If you want to include filtered frames in the analysis calculations, you must obtain counter values at the bridge station for the bridge being evaluated.
  3. For the IBM 8209, the IBM LAN Manager Version 2.0 recognizes an Ethernet/IEEE 802.3 LAN segment as a CSMA/CD LAN segment, but not specifically as Ethernet or IEEE 802.3.

- Use the **Remote Bridge Performance Analysis Worksheet For the IBM LAN Manager** at an IBM LAN Manager Version 2.0 station for the IBM Token-Ring Network Bridge Program versions using the remote bridge function.

  Notes:

  1. The "Frames not forwarded, Filtered" counter does not appear on the IBM LAN Manager Bridge Performance Counters panel or in the counter file. If you want to include filtered frames in the analysis calculations, you must obtain counter values at the bridge station for the bridge being evaluated.
  2. The "Bytes not forwarded, Telecommunications Link Error" counter does not appear on the IBM LAN Manager Bridge Performance Counters panel. The counter is recorded in the IBM LAN Manager counter file, and does appear on the Bridge Performance Counters panel at the bridge station.

Table 13-8 on page 13-23 shows which counters are displayed by each bridge program and IBM LAN Manager, and which counters are recorded in the IBM LAN Manager Version 2.0 counter file.

The accumulated counter values recorded (in "Results" spaces) on these worksheets are used in the computations shown on the Bridge Performance Analysis Calculations worksheets. Each counter value is identified by a descriptor (A1, for example). These descriptors identify the counter values to use in the computations. The descriptors do not appear on the Bridge Performance Counters panel.

The copy of the bridge performance counters that is used by the bridge programs to respond to network manager requests cannot be reset to zeros before beginning a measurement period. This allows multiple network manager programs to access the same performance counter values.

The counters must be read twice, once at the beginning of a measurement period, and again at the end of the period. The result of taking the difference of the two readings for each counter is the counter value accumulated during the measurement period.

To use the IBM LAN Manager version of the Bridge Performance Analysis worksheets:

Note: The times are displayed and should be recorded on the worksheet in the format HH:MM:SS, where H = hour, M = minute, and S = second. (08:35:20 means 35 minutes and 20 seconds after 8 o'clock.)

1. Select the worksheet for the bridge program, and function (local or remote) if applicable, being evaluated. Make at least one copy of the blank original worksheet. Save the original for copying again later.
2. Fill in the name of the bridge on a copy of the worksheet. You will need to know the name by which the bridge is defined to the IBM LAN Manager.
3. Determine the length of time for the measurement period.
4. At the IBM LAN Manager station, select **Bridge Profile** from the **Bridge Functions** panel of the IBM LAN Manager. Type the name of the bridge for which you want information.
5. Use the Bridge Version information from the panel to determine the Bridge Program Level.

   The Bridge Program Level is the first four characters shown (two for the version and two for the release). Thus, "0200" would be level 2.0. You may want to refer to the panel Help information.

   Record the Bridge Program Level on the copy of the worksheet.
6. Display the **Bridge Performance Counters** panel (the second **Bridge Profile** panel).
7. On the worksheet, record:
   - The LAN Segment Types
   - The time and date of this first reading of the counter values
   - The counter values shown on the panel; use the spaces labeled "First."

8 Wait until the desired measurement period has elapsed.

You may use other IBM LAN Manager functions during the measurement period.

9 At the end of the desired measurement period, return to the **Bridge Profile** function and display the **Performance Counters** panel again.

You must return to the **Bridge Profile** to display the current performance counter values.

10 On the worksheet, record the time and date of the second reading of the counter values. Record the performance counter values shown on the panel; use the spaces labeled "Second."

11 Subtract the readings labeled "First" from the readings labeled "Second," and record the answers in the spaces labeled "Result."

If a reading labeled "Second" is less than a reading labeled "First," this means that the counter has "rolled over" and resumed counting from zero during the measurement period. In this case, the correct "Result" can be obtained by adding the maximum value reached by the counter ("Roll over count") to the "Result," as follows:

Result = (Roll over count) + (Second) - (First)

The "Roll over counts" are:

For the 2-byte counters:	65,536
For the 4-byte counters:	4,294,967,296
For the 6-byte counters:	281,474,976,710,656

Counter lengths are shown in the tables on pages 13-14 and 13-14.

If you suspect that a counter may have "rolled over" more than once during the measurement period (an unlikely occurrence), repeat the measurement using a shorter measurement period.

12 Add the "Result" values for the two LAN segments to obtain and record the bridge totals.

13 Give the completed worksheet to your network administrator or to the person who will use the Bridge Performance Analysis Calculations worksheets.

Bridge Performance Analysis Worksheet
for the IBM LAN Manager

Instructions for completing this worksheet are on the back of the worksheet.

Bridge Identification ________________ **Bridge Program Level** ________________

First Reading of Counters ___- ___ - ___ at ___ : ___ : ___

Second Reading of Counters ___- ___ - ___ at ___ : ___ : ___

LAN Segment Types ________________ ________________

Frames Forwarded Values for:		**LAN Segment** ________	+	**LAN Segment** ________	=	**Bridge Total**
Broadcast frames	Second	________		________		
	− **First:**	________		________		
	= Result:	**(A1)** ________	+	**(A2)** ________	=	**(A3)** ________
Broadcast bytes	Second	________		________		
	− **First:**	________		________		
	= Result:	**(B1)** ________	+	**(B2)** ________	=	**(B3)** ________
Non-broadcast frames	Second	________		________		
	− **First:**	________		________		
	= Result:	**(C1)** ________	+	**(C2)** ________	=	**(C3)** ________
Non-broadcast bytes	Second	________		________		
	− **First:**	________		________		
	= Result:	**(D1)** ________	+	**(D2)** ________	=	**(D3)** ________

Frames Not Forwarded Because:		**LAN Segment** ________	+	**LAN Segment** ________	=	**Bridge Total**
Target LAN segment inoperative	Second	________		________		
	− **First:**	________		________		
	= Result:	**(E1)** ________	+	**(E2)** ________	=	**(E3)** ________
Adapter congestion	Second	________		________		
	− **First:**	________		________		
	= Result:	**(F1)** ________	+	**(F2)** ________	=	**(F3)** ________
Other reasons	Second	________		________		
	− **First:**	________		________		
	= Result:	**(G1)** ________	+	**(G2)** ________	=	**(G3)** ________

At the LAN Manager station:

1. Use the Bridge Profile function to display the first **Bridge Profile** panel.

2. Record the Bridge Program Level on the worksheet (the first four characters of the Bridge Version information).

3. Display the **Bridge Profile Performance Counters** panel (the second **Bridge Profile** panel).

4. Write on the worksheet:

   - Date and time of the first reading
   - LAN segment types
   - LAN segment numbers.

5. In the spaces labeled "First," write the values of the counters shown on the panel.

6. Wait ______ minutes. *(Write the length of the measurement period in the blank space.)* Then display the Bridge Profile Performance Counters again.

7. Write on the worksheet the date and time of the second reading.

8. In the spaces labeled "Second," write the values of the counters shown on the panel.

9. Subtract the "First" values from the "Second" values. Write the answers in the appropriate "Result" spaces.

   Note: If the "First" value is larger than the "Second" value for a counter, the counter rolled over during the measurement period. Follow the instructions in the *IBM Local Area Network Administrator's Guide* to obtain the correct result (page B-15).

10. Add the "Result" values for the two LAN segments to obtain each Bridge Total.

Remote Bridge Performance Analysis Worksheet

(Use with the IBM LAN Manager Version 2.0)

Instructions for completing this worksheet are on the back of the worksheet.

Bridge Identification ________________ **Bridge Program Level** ________________

First Reading of Counters ___- ___ - ___ at ___ : ___ : ___

Second Reading of Counters ___- ___ - ___ at ___ : ___ : ___

LAN Segment Types ________________ ________________

Frames Forwarded Values for:		**LAN Segment** ________	+	**LAN Segment** ________	=	**Bridge Total**
Broadcast frames	Second	________		________		
	− **First:**	________		________		
	= Result:	**(Q1)** ________	+	**(Q2)** ________	=	**(Q3)** ________
Broadcast bytes	Second	________		________		
	− **First:**	________		________		
	= Result:	**(R1)** ________	+	**(R2)** ________	=	**(R3)** ________
Non-broadcast frames	Second	________		________		
	− **First:**	________		________		
	= Result:	**(S1)** ________	+	**(S2)** ________	=	**(S3)** ________
Non-broadcast bytes	Second	________		________		
	− **First:**	________		________		
	= Result:	**(T1)** ________	+	**(T2)** ________	=	**(T3)** ________

Frames Not Forwarded Because:		**LAN Segment** ________	+	**LAN Segment** ________	=	**Bridge Total**
Target LAN segment inoperative	Second	________		________		
	− **First:**	________		________		
	= Result:	**(U1)** ________	+	**(U2)** ________	=	**(U3)** ________
Adapter congestion	Second	________		________		
	− **First:**	________		________		
	= Result:	**(V1)** ________	+	**(V2)** ________	=	**(V3)** ________
Telecommunications link error (frames)	Second	________		________		
	− **First:**	________		________		
	= Result:	**(W1)** ________	+	**(W2)** ________	=	**(W3)** ________
Other reasons	Second	________		________		
	− **First:**	________		________		
	= Result:	**(Z1)** ________	+	**(Z2)** ________	=	**(Z3)** ________

At the LAN Manager station:

1 Use the Bridge Profile function to display the first **Bridge Profile** panel.

2 Record the Bridge Program Level on the worksheet (the first four characters of the Bridge Version information).

3 Display the **Bridge Profile Performance Counters** panel (the second **Bridge Profile** panel).

4 Write on the worksheet:

- Date and time of the first reading
- LAN segment types
- LAN segment numbers.

5 In the spaces labeled "First," write the values of the counters shown on the panel.

6 Wait ______ minutes. *(Write the length of the measurement period in the blank space.)* Then display the Bridge Profile Performance Counters again.

7 Write on the worksheet the date and time of the second reading.

8 In the spaces labeled "Second," write the values of the counters shown on the panel.

9 Subtract the "First" values from the "Second" values. Write the answers in the appropriate "Result" spaces.

Note: If the "First" value is larger than the "Second" value for a counter, the counter rolled over during the measurement period. Follow the instructions in the *IBM Local Area Network Administrator's Guide* to obtain the correct result (page B-15).

10 Add the "Result" values for the two LAN segments to obtain each Bridge Total.

Bridge Performance Analysis Worksheets for the IBM LAN Network Manager

The Bridge Performance Analysis worksheets for the IBM LAN Network Manager are used at IBM LAN Network Manager stations to record performance counter values accumulated by one bridge during one measurement period.

- Use the **Bridge Performance Analysis Worksheet for the IBM LAN Network Manager** at an IBM LAN Network Manager station for the IBM 8209 LAN Bridge and for all bridge programs except those using the remote bridge function. (See Table B-1 on page B-1.)
- Use the **Remote Bridge Performance Analysis Worksheet for the IBM LAN Network Manager** at an IBM LAN Network Manager Version station for the IBM Token-Ring Network Bridge Program versions using the remote bridge function.

Table 13-8 on page 13-23 shows which counters are displayed by each bridge program and IBM LAN Network Manager, and which counters are recorded in the IBM LAN Network Manager Version 1.0 Bridge Performance Table.

The accumulated counter values recorded (in "Results" spaces) on these worksheets are used in the computations shown on the Bridge Performance Analysis Calculations worksheets. Each counter value is identified by a descriptor (A1, for example). These descriptors identify the counter values to use in the computations. The descriptors do not appear on the Bridge Performance Counters panel.

The copy of the bridge performance counters that is used by the bridge programs to respond to network manager requests cannot be reset to zeros before beginning a measurement period. This allows multiple network manager programs to access the same performance counter values.

The counters must be read twice, once at the beginning of a measurement period, and again at the end of the period. The result of taking the difference of the two readings for each counter is the counter value accumulated during the measurement period.

To use the IBM LAN Network Manager version of the Bridge Performance Analysis worksheets:

Note: The times are displayed and should be recorded on the worksheet in the format HH:MM:SS, where H = hour, M = minute, and S = second. (08:35:20 means 35 minutes and 20 seconds after 8 o'clock.)

1. Select the worksheet for the bridge, and function (local or remote) if applicable, being evaluated. Make at least one copy of the blank original worksheet. Save the original for copying again later.
2. Fill in the name of the bridge on a copy of the worksheet. You will need to know the name by which the bridge is defined to the IBM LAN Network Manager.
3. Determine the length of time for the measurement period.

Bridge Performance Analysis Worksheet

for the IBM LAN Network Manager

Instructions for completing this worksheet are on the back of the worksheet.

Bridge Name/Type/Number ________________ **Bridge Version** ________________

First Reading of Counters ___-___-___ at ___:___:___

Second Reading of Counters ___-___-___ at ___:___:___

LAN Segment Types ________________ ________________

Frames Forwarded Values for:		**LAN Segment** ________	+ **LAN Segment** ________	= **Bridge Total**
Broadcast frames	Second			
	− **First:**			
	= Result:	**(A1)**	+ **(A2)**	= **(A3)**
Broadcast bytes	Second			
	− **First:**			
	= Result:	**(B1)**	+ **(B2)**	= **(B3)**
Non-broadcast frames	Second			
	− **First:**			
	= Result:	**(C1)**	+ **(C2)**	= **(C3)**
Non-broadcast bytes	Second			
	− **First:**			
	= Result:	**(D1)**	+ **(D2)**	= **(D3)**

Frames Not Forwarded Because:		**LAN Segment** ________	+ **LAN Segment** ________	= **Bridge Total**
Target LAN segment inoperative	Second			
	− **First:**			
	= Result:	**(E1)**	+ **(E2)**	= **(E3)**
Adapter congestion	Second			
	− **First:**			
	= Result:	**(F1)**	+ **(F2)**	= **(F3)**
Other reasons	Second			
	− **First:**			
	= Result:	**(G1)**	+ **(G2)**	= **(G3)**

At the LAN Network Manager station:

1 Use the Display Profile Action of the Defined Bridge window to display the first **Bridge Profile** window.

2 Record the Bridge Name, Type, Number, and Version on the worksheet.

3 Use the Performance Data Action to display the performance counters.

4 Write on the worksheet:

- Date and time of the first reading
- LAN segment types
- LAN segment numbers.

5 In the spaces labeled "First," write the values of the counters shown on the panel.

6 Wait _______ minutes from the time of the first reading. *(Write the length of the measurement period in the blank space.)* Then click on Refresh.

7 Write on the worksheet the date and time of the second reading.

8 In the spaces labeled "Second," write the values of the counters shown on the panel.

9 Subtract the "First" values from the "Second" values. Write the answers in the appropriate "Result" spaces.

Note: If the "First" value is larger than the "Second" value for a counter, the counter rolled over during the measurement period. Follow the instructions in the *IBM Local Area Network Administrator's Guide* to obtain the correct result (page B-15).

10 Add the "Result" values for the two LAN segments to obtain each Bridge Total.

Remote Bridge Performance Analysis Worksheet
for the IBM LAN Network Manager

Instructions for completing this worksheet are on the back of the worksheet.

Bridge Name/Type/Number ________________ **Bridge Version** ________________

First Reading of Counters ___- ___ - ___ at ___ : ___ : ___

Second Reading of Counters ___- ___ - ___ at ___ : ___ : ___

LAN Segment Types ____________ ____________

Frames Forwarded Values for:		**LAN Segment** ______	+	**LAN Segment** ______	=	**Bridge Total**
Broadcast frames	Second	______		______		
	− **First:**	______		______		
	= Result:	**(Q1)** ______	+	**(Q2)** ______	=	**(Q3)** ______
Broadcast bytes	Second	______		______		
	− **First:**	______		______		
	= Result:	**(R1)** ______	+	**(R2)** ______	=	**(R3)** ______
Non-broadcast frames	Second	______		______		
	− **First:**	______		______		
	= Result:	**(S1)** ______	+	**(S2)** ______	=	**(S3)** ______
Non-broadcast bytes	Second	______		______		
	− **First:**	______		______		
	= Result:	**(T1)** ______	+	**(T2)** ______	=	**(T3)** ______

Frames Not Forwarded Because:		**LAN Segment** ______	+	**LAN Segment** ______	=	**Bridge Total**
Target LAN segment inoperative	Second	______		______		
	− **First:**	______		______		
	= Result:	**(U1)** ______	+	**(U2)** ______	=	**(U3)** ______
Adapter congestion	Second	______		______		
	− **First:**	______		______		
	= Result:	**(V1)** ______	+	**(V2)** ______	=	**(V3)** ______
Telecommunications link error (frames)	Second	______		______		
	− **First:**	______		______		
	= Result:	**(W1)** ______	+	**(W2)** ______	=	**(W3)** ______
Other reasons	Second	______		______		
	− **First:**	______		______		
	= Result:	**(Z1)** ______	+	**(Z2)** ______	=	**(Z3)** ______

At the LAN Network Manager station:

1 Use the Display Profile Action of the Defined Bridge window to display the first **Bridge Profile** window.

2 Record the Bridge Name, Type, Number, and Version on the worksheet.

3 Use the Performance Data Action to display the performance counters.

4 Write on the worksheet:

- Date and time of the first reading
- LAN segment types
- LAN segment numbers.

5 In the spaces labeled "First," write the values of the counters shown on the panel.

6 Wait ______ minutes from the time of the first reading. *(Write the length of the measurement period in the blank space.)* Then click on Refresh.

7 Write on the worksheet the date and time of the second reading.

8 In the spaces labeled "Second," write the values of the counters shown on the panel.

9 Subtract the "First" values from the "Second" values. Write the answers in the appropriate "Result" spaces.

Note: If the "First" value is larger than the "Second" value for a counter, the counter rolled over during the measurement period. Follow the instructions in the *IBM Local Area Network Administrator's Guide* to obtain the correct result (page B-15).

10 Add the "Result" values for the two LAN segments to obtain each Bridge Total.

Bridge Performance Analysis Calculations Worksheets

The Bridge Performance Analysis Calculations worksheets contain bridge traffic measurement computations to help you evaluate traffic flow through a bridge. The computations use the performance counter values recorded on the Bridge Performance Analysis worksheets at a bridge or IBM LAN Manager station.

Be sure to use the appropriate Bridge Performance Analysis worksheet with each calculations worksheet:

- The **Bridge Performance Analysis Calculations Worksheet** is used with:
  - The Bridge Performance Analysis Worksheet (For use with the IBM Token-Ring Network Bridge Program Versions 1.1 and 2.0)
  - The Bridge Performance Analysis Worksheet for the IBM LAN Manager (Versions 1.0 and 2.0), when the bridge program for which traffic is being evaluated is
    - IBM Token-Ring Network Bridge Program Version 1.1
    - IBM Token-Ring Network Bridge Program Version 2.0
    - IBM Token-Ring Network Bridge Program Version 2.1 using the local bridge function
    - IBM 8209 LAN Bridge

    Note: For the IBM Token-Ring Network Bridge Program Version 2.1 or later local bridge function, the "Frames not forwarded, Filtered" counter does not appear on the IBM LAN Manager Bridge Performance Counters panel, or in the IBM LAN Manager Version 2.0 counter file data records, or in the calculations on the Bridge Performance Analysis Calculations Worksheet. If you want to include this counter in analysis calculations, you must obtain the counter values at the bridge station and use the calculations on the Bridge Performance Analysis Calculations Worksheet (Using the IBM Token-Ring Network Bridge Program Version 2.1 or later Local Bridge Function). The results from calculations done for the Bridge Program Version 2.1 or later without the "filtered" counter value (or assuming a value of zero for the counter) may be adequate approximations. For more exact results, you must use the calculations that include the "filtered" counter value. You cannot obtain this counter for the IBM 8209.

- The **Bridge Performance Analysis Calculations Worksheet for the IBM PC Network Bridge Program** is used with:
  - The Bridge Performance Analysis Worksheet for the IBM PC Network Bridge Program
  - The Bridge Performance Analysis Worksheet for the IBM LAN Manager (if the IBM LAN Manager Version 2.0 is being used to evaluate traffic for the IBM PC Network Bridge Program).

    Note: For the IBM PC Network Bridge Program, the "Frames Not Routed Across This Bridge" counter does not appear on the IBM LAN Manager Bridge Performance Counters panel or in the IBM LAN Manager Version 2.0 counter file data records. If you want to include this counter in analysis calculations, you must obtain the counter values at a bridge station. You may be able to obtain adequate approximations in the calculations that use this counter (the ones involving adapter congestion) by assuming a counter value of zero in the calculations. A more exact result requires using the counter values obtained at the bridge station.

- The **Bridge Performance Analysis Calculations Worksheet** (Using the IBM Token-Ring Network Bridge Program Version 2.1 or later Local Bridge Function) is used with
  - The Bridge Performance Analysis Worksheet (Using the Local Bridge Function); for use with IBM Token-Ring Network Bridge Program Version 2.1 or later and the IBM 8209 LAN Bridge.
- The **Remote Bridge Performance Analysis Calculations Worksheet** is used with
  - The Bridge Performance Analysis Worksheet (Using the Remote Bridge Function); for use with IBM Token-Ring Network Bridge Program Version 2.1 or later.
  - The Remote Bridge Performance Analysis Worksheet For the IBM LAN Manager (IBM LAN Manager Version 2.0 only).

    Note: For the IBM Token-Ring Network Bridge Program Version 2.1 or later remote bridge function, the "Frames not forwarded, Filtered" counter does not appear on the IBM LAN Manager Bridge Performance Counters panel, or in the IBM LAN Manager Version 2.0 counter file data records. If you want to include this counter in analysis calculations, you must obtain the counter values at the bridge station. The results from calculations done for the Bridge Program without the "filtered" counter value (or assuming a value of zero for the counter) may be adequate approximations. For more exact results, you must use the calculations that include the "filtered" counter value.

To use the Bridge Performance Analysis Calculations worksheets:

1 Select the worksheet for the bridge, and function (local or remote) if applicable, being evaluated. Make at least one copy of the blank original worksheet (both sides). Save the original to copy again later.

2 Obtain the completed Bridge Performance Analysis Worksheet containing the times and performance counter values from the bridge or IBM LAN Manager station.

3 Write the date, bridge identification, bridge program level, LAN segment types, and LAN segment numbers on the Calculations Worksheet (copy from the Performance Analysis Worksheet).

4 Calculate and record on the worksheet the value of J, the length of the measurement period in seconds:

The times were recorded in the format HH:MM:SS, where H = hour, M = minute, and S = second. (08:35:20 means 35 minutes and 20 seconds after 8 o'clock.)

a. Convert the first time shown on the Bridge Performance Analysis Worksheet to seconds (the time the bridge counters were reset to zeros at the bridge station or the first time the counters were read at the IBM LAN Manager station):

(((HH x 60) + MM) x 60) + SS = J1

b. Convert the second time shown on the Bridge Performance Analysis Worksheet to seconds (the time the bridge counters were read at the bridge station or the second time the counters were read at the IBM LAN Manager station):

(((HH x 60) + MM) x 60) + SS = J2

c. Subtract the first time in seconds from the second time in seconds to obtain and record the value for J on the Calculations Worksheet:

(J2 - J1) = J

5 Perform the calculations indicated by the formulas on both sides of the Calculations Worksheet. Record the answers in the spaces provided.

- Each performance counter is identified on the Bridge Performance Analysis Worksheets and in the formulas by a descriptor (A1, for example). These descriptors identify a LAN segment value or a bridge total.

  For example:

  A1 = Broadcast frames forwarded from the LAN segment in the left column

  A2 = Broadcast frames forwarded from the LAN segment in the right column

  A3 = Broadcast frames forwarded from either LAN segment to the other for the bridge total. Where the descriptors appear in the formulas, use the corresponding counter values from the Bridge Performance Analysis Worksheets.

- Calculation answers that are used in later calculations are identified by a descriptor to indicate a LAN segment value or a bridge total. Where these appear in the formulas to the left of an "=" sign, use the corresponding value obtained in an earlier calculation and written to the right of an "=" sign on the Calculations Worksheets.

Bridge Performance Analysis Calculations Worksheet

(For use with local bridge function - IBM 8209 LAN Bridge and IBM Token-Ring Network Bridge Version 1.1 and later)

Date _________ **Bridge Identification** ___________
Bridge Program Level _______ **LAN Segment Types** _________ _________
Measurement wait time in seconds: J = ___________

Broadcast Frames Forwarded:

LAN Segment ________	**LAN Segment** ________	**Bridge Total**
Frames per second:		
$\frac{A1}{J} = K1$ ________	$\frac{A2}{J} = K2$ ________	$\frac{A3}{J} = K3$ ________
Bytes per second:		
$\frac{B1}{J} = L1$ ________	$\frac{B2}{J} = L2$ ________	$\frac{B3}{J} = L3$ ________
Mean frame bytes:		
$\frac{B1}{A1} =$ ________	$\frac{B2}{A2} =$ ________	$\frac{B3}{A3} =$ ________

Non-Broadcast Frames Forwarded:

LAN Segment ________	**LAN Segment** ________	**Bridge Total**
Frames per second:		
$\frac{C1}{J} = M1$ ________	$\frac{C2}{J} = M2$ ________	$\frac{C3}{J} = M3$ ________
Bytes per second:		
$\frac{D1}{J} = N1$ ________	$\frac{D2}{J} = N2$ ________	$\frac{D3}{J} = N3$ ________
Mean frame bytes:		
$\frac{D1}{C1} =$ ________	$\frac{D2}{C2} =$ ________	$\frac{D3}{C3} =$ ________

Total Frames Forwarded:

LAN Segment ________	**LAN Segment** ________	**Bridge Total**
Frames per second:		
$K1 + M1 =$ ________	$K2 + M2 =$ ________	$K3 + M3 =$ ________
Bytes per second:		
$L1 + N1 =$ ________	$L2 + N2 =$ ________	$L3 + N3 =$ ________
Mean frame bytes:		
$\frac{B1 + D1}{A1 + C1} =$ ________	$\frac{B2 + D2}{A2 + C2} =$ ________	$\frac{B3 + D3}{A3 + C3} =$ ________

(Continued on other side)

Total Frames Received by the Bridge:

LAN Segment ________	LAN Segment ________	Bridge Total
$(A1 + C1 + E1 + F1 + G1) =$	$(A2 + C2 + E2 + F2 + G2) =$	$(A3 + C3 + E3 + F3 + G3) =$
P1 ________________	P2 ________________	P3 ________________

Percent of Frames Received That Were Not Forwarded:

LAN Segment ________	LAN Segment ________	Bridge Total
Target LAN Segment inoperative:		
$\frac{(100 \times E1)}{P1} =$ ____________	$\frac{(100 \times E2)}{P2} =$ ____________	$\frac{(100 \times E3)}{P3} =$ ____________
Adapter congestion:		
$\frac{(100 \times F1)}{P1} =$ ____________	$\frac{(100 \times F2)}{P2} =$ ____________	$\frac{(100 \times F3)}{P3} =$ ____________
Other reasons:		
$\frac{(100 \times G1)}{P1} =$ ____________	$\frac{(100 \times G2)}{P2} =$ ____________	$\frac{(100 \times G3)}{P3} =$ ____________
Percent of total frames received that were not forwarded:		
$\frac{100 \times (E1 + F1 + G1)}{P1}$	$\frac{100 \times (E2 + F2 + G2)}{P2}$	$\frac{100 \times (E3 + F3 + G3)}{P3}$
= ____________	= ____________	= ____________

Bridge Performance Analysis Calculations Worksheet

(Using the IBM Token-Ring Network Bridge Program Version 2.1 and Later Local Bridge Function at the Bridge Station)

Date _________ **Bridge Identification** ___________

Bridge Program Level ______ **LAN Segment Types** _________ _________

Measurement wait time in seconds: J = ___________

Broadcast Frames Forwarded:

LAN Segment ________	LAN Segment ________	Bridge Total
Frames per second:		
$\frac{A1}{J} = K1$ ________________	$\frac{A2}{J} = K2$ ________________	$\frac{A3}{J} = K3$ ________________
Bytes per second:		
$\frac{B1}{J} = L1$ ________________	$\frac{B2}{J} = L2$ ________________	$\frac{B3}{J} = L3$ ________________
Mean frame bytes:		
$\frac{B1}{A1} =$ ________________	$\frac{B2}{A2} =$ ________________	$\frac{B3}{A3} =$ ________________

Non-Broadcast Frames Forwarded:

LAN Segment ________	LAN Segment ________	Bridge Total
Frames per second:		
$\frac{C1}{J} = M1$ ________________	$\frac{C2}{J} = M2$ ________________	$\frac{C3}{J} = M3$ ________________
Bytes per second:		
$\frac{D1}{J} = N1$ ________________	$\frac{D2}{J} = N2$ ________________	$\frac{D3}{J} = N3$ ________________
Mean frame bytes:		
$\frac{D1}{C1} =$ ________________	$\frac{D2}{C2} =$ ________________	$\frac{D3}{C3} =$ ________________

Total Frames Forwarded:

LAN Segment ________	LAN Segment ________	Bridge Total
Frames per second:		
$K1 + M1 =$ ______________	$K2 + M2 =$ ______________	$K3 + M3 =$ ______________
Bytes per second:		
$L1 + N1 =$ ______________	$L2 + N2 =$ ______________	$L3 + N3 =$ ______________
Mean frame bytes:		
$\frac{B1 + D1}{A1 + C1} =$ ______________	$\frac{B2 + D2}{A2 + C2} =$ ______________	$\frac{B3 + D3}{A3 + C3} =$ ______________

(Continued on other side)

Total Frames Received by the Bridge:

LAN Segment ________	LAN Segment ________	Bridge Total
$(A1 + C1 + E1 + F1 + H1) =$	$(A2 + C2 + E2 + F2 + H2) =$	$(A3 + C3 + E3 + F3 + H3) =$
P1 ________________	P2 ________________	P3 ________________

Percent of Frames Received That Were Not Forwarded:

LAN Segment ________	LAN Segment ________	Bridge Total

Target LAN Segment inoperative:

$\frac{(100 \times E1)}{P1} =$ ____________ $\frac{(100 \times E2)}{P2} =$ ____________ $\frac{(100 \times E3)}{P3} =$ ____________

Adapter congestion:

$\frac{(100 \times F1)}{P1} =$ ____________ $\frac{(100 \times F2)}{P2} =$ ____________ $\frac{(100 \times F3)}{P3} =$ ____________

Filtered:

$\frac{(100 \times G1)}{P1} =$ ____________ $\frac{(100 \times G2)}{P2} =$ ____________ $\frac{(100 \times G3)}{P3} =$ ____________

Other reasons:

$\frac{(100 \times H1)}{P1} =$ ____________ $\frac{(100 \times H2)}{P2} =$ ____________ $\frac{(100 \times H3)}{P3} =$ ____________

Percent of total frames received that were not forwarded due to error conditions:

$\frac{100 \times (E1 + F1 + H1)}{P1}$ $\frac{100 \times (E2 + F2 + H2)}{P2}$ $\frac{100 \times (E3 + F3 + H3)}{P3}$

= ____________ = ____________ = ____________

Remote Bridge Performance Analysis Calculations Worksheet

Date _________ **Bridge Identification** ___________
Bridge Program Level ______ **LAN Segment Types** _________ _________

Measurement wait time in seconds: J = ___________

Broadcast Frames Forwarded:

LAN Segment ________	LAN Segment ________	Bridge Total
Frames per second:		
$\frac{Q1}{J} = A1$ ______________	$\frac{Q2}{J} = A2$ ______________	$\frac{Q3}{J} = A3$ ______________
Bytes per second:		
$\frac{R1}{J} = B1$ ______________	$\frac{R2}{J} = B2$ ______________	$\frac{R3}{J} = B3$ ______________
Mean frame bytes:		
$\frac{R1}{Q1} =$ ______________	$\frac{R2}{Q2} =$ ______________	$\frac{R3}{Q3} =$ ______________

Non-Broadcast Frames Forwarded:

LAN Segment ________	LAN Segment ________	Bridge Total
Frames per second:		
$\frac{S1}{J} = C1$ ______________	$\frac{S2}{J} = C2$ ______________	$\frac{S3}{J} = C3$ ______________
Bytes per second:		
$\frac{T1}{J} = D1$ ______________	$\frac{T2}{J} = D2$ ______________	$\frac{T3}{J} = D3$ ______________
Mean frame bytes:		
$\frac{T1}{S1} =$ ______________	$\frac{T2}{S2} =$ ______________	$\frac{T3}{S3} =$ ______________

Total Frames Forwarded:

LAN Segment ________	LAN Segment ________	Bridge Total
Frames per second:		
$A1 + C1 =$ ____________	$A2 + C2 =$ ____________	$A3 + C3 =$ ____________
Bytes per second:		
$B1 + D1 =$ ____________	$B2 + D2 =$ ____________	$B3 + D3 =$ ____________
Mean frame bytes:		
$\frac{R1 + T1}{Q1 + S1} =$ ____________	$\frac{R2 + T2}{Q2 + S2} =$ ____________	$\frac{R3 + T3}{Q3 + S3} =$ ____________

(Continued on other side)

Total Frames Received by the Bridge (excluding telecommunications link error frames):

LAN Segment ________	**LAN Segment ________**	**Bridge Total**
(Q1 + S1 + U1 + V1 + Y1 + Z1) =	(Q2 + S2 + U2 + V2 + Y2 + Z2) =	(Q3 + S3 + U3 + V3 + Y3 + Z3) =
E1 ______________	E2 ______________	E3 ______________

Percent of Frames Received That Were Not Forwarded (excluding telecommunications link error frames):

LAN Segment ________	**LAN Segment ________**	**Bridge Total**
Target LAN Segment inoperative:		
$\frac{(100 \times U1)}{E1} =$ ______________	$\frac{(100 \times U2)}{E2} =$ ______________	$\frac{(100 \times U3)}{E3} =$ ______________
Adapter congestion:		
$\frac{(100 \times V1)}{E1} =$ ______________	$\frac{(100 \times V2)}{E2} =$ ______________	$\frac{(100 \times V3)}{E3} =$ ______________
Filtered:		
$\frac{(100 \times Y1)}{E1} =$ ______________	$\frac{(100 \times Y2)}{E2} =$ ______________	$\frac{(100 \times Y3)}{E3} =$ ______________
Other reasons:		
$\frac{(100 \times Z1)}{E1} =$ ______________	$\frac{(100 \times Z2)}{E2} =$ ______________	$\frac{(100 \times Z3)}{E3} =$ ______________

Percent of Total Frames Received That Were Not Forwarded Due to Error Conditions (excluding telecommunications link error frames and filtered frames):

LAN Segment ________	**LAN Segment ________**	**Bridge Total**
$\frac{100 \times (U1 + V1 + Z1)}{E1}$	$\frac{100 \times (U2 + V2 + Z2)}{E2}$	$\frac{100 \times (U3 + V3 + Z3)}{E3}$
= ______________	= ______________	= ______________

Percent of Total Frames on the Telecommunications Link That Were Not Forwarded Due to Telecommunications Link Errors:

LAN Segment ________	**LAN Segment ________**	**Bridge Total**
$\frac{(100 \times W1)}{(Q1 + S1 + W1)} =$ __________	$\frac{(100 \times W2)}{(Q2 + S2 + W2)} =$ __________	$\frac{(100 \times W3)}{(Q3 + S3 + W3)} =$ __________

Bridge Performance Analysis Calculations Worksheet
for the IBM PC Network Bridge Program

Date ________ **Bridge Identification** ___________
Bridge Program Level ______ **LAN Segment Types** _________ _________

Measurement wait time in seconds: J = ___________

Broadcast Frames Forwarded:

LAN Segment ________	**LAN Segment** ________	**Bridge Total**
Frames per second:		
$\frac{A1}{J} = K1$ ________________	$\frac{A2}{J} = K2$ ________________	$\frac{A3}{J} = K3$ ________________
Bytes per second:		
$\frac{B1}{J} = L1$ ________________	$\frac{B2}{J} = L2$ ________________	$\frac{B3}{J} = L3$ ________________
Mean frame bytes:		
$\frac{B1}{A1} =$ ________________	$\frac{B2}{A2} =$ ________________	$\frac{B3}{A3} =$ ________________

Non-Broadcast Frames Forwarded:

LAN Segment ________	**LAN Segment** ________	**Bridge Total**
Frames per second:		
$\frac{C1}{J} = M1$ ________________	$\frac{C2}{J} = M2$ ________________	$\frac{C3}{J} = M3$ ________________
Bytes per second:		
$\frac{D1}{J} = N1$ ________________	$\frac{D2}{J} = N2$ ________________	$\frac{D3}{J} = N3$ ________________
Mean frame bytes:		
$\frac{D1}{C1} =$ ________________	$\frac{D2}{C2} =$ ________________	$\frac{D3}{C3} =$ ________________

Total Frames Forwarded:

LAN Segment ________	**LAN Segment** ________	**Bridge Total**
Frames per second:		
$K1 + M1 =$ _____________	$K2 + M2 =$ _____________	$K3 + M3 =$ _____________
Bytes per second:		
$L1 + N1 =$ _____________	$L2 + N2 =$ _____________	$L3 + N3 =$ _____________
Mean frame bytes:		
$\frac{B1 + D1}{A1 + C1} =$ _____________	$\frac{B2 + D2}{A2 + C2} =$ _____________	$\frac{B3 + D3}{A3 + C3} =$ _____________

(Continued on other side)

Total Frames Received by the Bridge:

LAN Segment ________	LAN Segment ________	Bridge Total
$(A1 + C1 + E1 + F1 + G1 + H1) =$	$(A2 + C2 + E2 + F2 + G2 + H2) =$	$(A3 + C3 + E3 + F3 + G3 + H3) =$
Q1 ______________	Q2 ______________	Q3 ______________

Total Frames That Should Be Forwarded through the Bridge (Other Than during Adapter Congestion):

LAN Segment ________	LAN Segment ________	Bridge Total
$(A1 + C1 + E1 + G1) =$	$(A2 + C2 + E2 + G2) =$	$(A3 + C3 + E3 + G3) =$
P1 ______________	P2 ______________	P3 ______________

Percentages:

LAN Segment ________	LAN Segment ________	Bridge Total

Percent of Frames Not Forwarded; Target LAN Segment Inoperative:

$\frac{(100 \times E1)}{P1} =$ ______________ $\frac{(100 \times E2)}{P2} =$ ______________ $\frac{(100 \times E3)}{P3} =$ ______________

Percent of Frames Not Forwarded; Other Reasons:

$\frac{(100 \times G1)}{P1} =$ ______________ $\frac{(100 \times G2)}{P2} =$ ______________ $\frac{(100 \times G3)}{P3} =$ ______________

Percent of Frames Not Forwarded (Other Than during Adapter Congestion):

$\frac{100 \times (E1 + G1)}{P1}$ = ______________ $\frac{100 \times (E2 + G2)}{P2}$ = ______________ $\frac{100 \times (E3 + G3)}{P3}$ = ______________

Percent of Frames Not Processed during Adapter Congestion:

$\frac{(100 \times F1)}{Q1} =$ ______________ $\frac{(100 \times F2)}{Q2} =$ ______________ $\frac{(100 \times F3)}{Q3} =$ ______________

Total Frames That Arrived at the Bridge and Were Not Forwarded:

$\frac{100 \times (E1 + F1 + G1)}{Q1}$ = ______________ $\frac{100 \times (E2 + F2 + G2)}{Q2}$ = ______________ $\frac{100 \times (E3 + F3 + G3)}{Q3}$ = ______________

Appendix C. Administration Activity Summary

Administration Activity Summary . . . C-3
- Key for the Activity Summary Charts . . . C-3
- Planning the Network Layout . . . C-5
- Preparing for Adapter and Attachment Feature Installation . . . C-5
- Planning for Network Address Administration . . . C-5
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Administration Activity Summary

The charts on the following pages list tasks and activities included in LAN administration, and indicate publications applicable to each task or activity.

Key for the Activity Summary Charts

The codes in the "Refer To" column of the charts are shown below, with the publications or other information to which they refer. The code **ADMN**, followed by a chapter number in parentheses, indicates the chapter of this manual containing information about the item in the list.

Code	Referenced Publication
ADMN	*IBM Local Area Network Administrator's Guide*
ADP	Adapter and attachment feature installation, test, and operation instructions
APPL	Publications packaged with application programs
ARF	*IBM Token-Ring Network Architecture Reference*
BRDG	IBM bridging products *User's Guides*
CBL	Cabling and building wiring information, including: *A Building Planning Guide for Communication Wiring* *IBM Cabling System Planning and Installation Guide* *IBM Cabling System Technical Interface Specification* *IBM Token-Ring Network Optical Fiber Cable Options* *IBM Token-Ring Network Telephone Twisted-Pair Media Guide* *Using the IBM Cabling System with Communication Products* *IBM Token-Ring Network Technology*
GSN	*IBM Token-Ring Network Guide for Small Networks*
HDWR	Publications packaged with hardware products
HMS	Hardware Maintenance Reference and Service manuals
ILAN	*Introduction to Local Area Networks*
INST	*IBM Token-Ring Network Installation Guide*
IPG	*IBM Token-Ring Network Introduction and Planning Guide* *IBM PC Network Broadband Planning Guide* *IBM PC Network Baseband Planning Guide*
LANACS	*IBM Local Area Network Asynchronous Connection Server Program*
LANM	Local area network management, including: *IBM LAN Manager User's Guide* *IBM PC 3270 Emulation Local Area Network Management Program* *IBM LAN Manager Entry User's Guide*
LHI	*IBM LAN Host Information*
LSP	Support programs, interfaces, and protocols, including adapter support, NETBIOS, APPC, TCP/IP, asynchronous communications, and operating system functions: *IBM Local Area Network Support Program User's Guide*
LTLW	*IBM LAN to LAN Wide Area Network Program*
OSYS	Operating system publications (including IBM PC DOS, OS/2 EE 1.1, AIX, VM, MVS, and SSP)
PCLN	Information about programs and operating systems that provide server functions, including OS/2 LAN Server publications and the *IBM PC Local Area Network Program User's Guide*

Code	Referenced Publication
PCPS	Computer *Guide to Operations* and *Quick Reference* publications
PDP	*IBM Token-Ring Network Problem Determination Guide*
STG	*IBM Token-Ring Network Starter Kit Guide*
TREF	*Technical Reference* manuals
TRPF	*IBM Token-Ring Network Trace and Performance Program User's Guide*

Planning the Network Layout

Task or Activity	Refer To
Identify network objectives, hardware requirements, and software requirements	ILAN, **ADMN** (Pt. 1; Ch. 8)
Design the physical layout of the network	IPG, CBL, GSN, **ADMN** (Pt. 1; Ch. 8)
Choose a numbering and labeling scheme for network components	IPG, CBL, **ADMN** (Ch. 8)
Prepare labels for network components and cable connections	IPG, CBL, **ADMN** (Ch. 8)
Document the layout on the charts and floor plans	IPG, **ADMN** (Ch. 8, 9)
Order spare components	IPG, **ADMN** (Ch. 8)

Preparing for Adapter and Attachment Feature Installation

Task or Activity	Refer To
Determine the type and number of adapters to install in each device	HDWR, APPL, **ADMN** (Pt. 1; Ch. 8, 9)
Determine what support programs and interfaces each adapter requires	ADP, OSYS, APPL, HDWR, LSP, PCPS, **ADMN** (Pt. 1; Ch. 8, 9)
Determine the values of hardware and load configuration parameters for each adapter	ADP, OSYS, APPL, HDWR, BRDG, LSP, **ADMN** (Ch. 8, 9)
Determine what addressing to use for each adapter	ADP, LSP, OSYS, **ADMN** (Ch. 8)
Prepare working copies of support programs and files	ADP, OSYS, HDWR, APPL, LSP, PCPS, **ADMN** (Ch. 8, 9)

Planning for Network Address Administration

Task or Activity	Refer To
Determine what addressing to use for each adapter (such as universally or locally administered)	ADP, PCPS, HDWR, APPL, LSP, OSYS, **ADMN** (Ch. 8)
Determine the formats and conventions required for names and addresses used by application programs, support programs, and interfaces to communicate on the network	APPL, LSP, HDWR, OSYS, **ADMN** (Ch. 8, 9)
Create guidelines and procedures for assigning and changing names and addresses in the network	APPL, HDWR, LSP, OSYS, **ADMN** (Ch. 8, 9)
Assign and document names and addresses used in the network	IPG, APPL, LSP, PCPS, OSYS **ADMN** (Ch. 8, 9)
Record adapter addresses and their associated devices in network documentation	IPG, **ADMN** (Ch. 8, 9)

Installing Network Adapters and Attachment Features

Task or Activity	Refer To
Set hardware configuration options and parameters for each adapter	ADP, OSYS, PCPS, HDWR, LSP, **ADMN** (Ch. 9)
Install each adapter in an attaching device	ADP, PCPS, HDWR
Set software configuration options and parameters for each adapter	ADP, PCPS, HDWR, OSYS, LSP, ADMN (Pt. 1)
Record the parameter settings in the network documentation	ADP, **ADMN** (Ch. 9)
Verify that each adapter is operating normally (run diagnostic tests, system tests, or other appropriate tests)	ADP, HMS, OSYS, PCPS, HDWR, **ADMN** (Ch. 9)
Use information displayed by the tests to verify that the adapter parameters were set correctly	HMS, ADP, OSYS, PCPS, **ADMN** (Ch. 9)
Use information displayed by the diagnostics to determine the universally administered adapter address for each workstation	HMS, PCPS, ADP, **ADMN** (Ch. 9)
Record the universally administered addresses in network documentation	IPG, **ADMN** (Ch. 8, 9)
Connect a cable to each adapter	ADP, INST, CBL

Verifying Network Operation after Installation

Task or Activity	Refer To
For each LAN segment:	
Select a few devices connected to each LAN segment	INST, IPG, APPL, ADP, LSP
Run an application program in each selected device to see that data can be transmitted over the LAN segment	INST, ADP, PCPS, PCLN, APPL, STG, **ADMN** (Ch. 9)
Resolve any problems	INST, PDP, APPL, OSYS, HDWR, **ADMN** (Ch. 11)
Connect the rest of the devices to the LAN segment	INST, APPL, HDWR, CBL
Verify all network cable connections and labeling	INST, CBL, HDWR, APPL **ADMN** (Ch. 9)
For interconnections and remote connections:	
Verify that each LAN segment, device, and network operates normally	INST, OSYS, HDWR, APPL, **ADMN** (Ch. 9)
Connect the devices that provide bridge and gateway functions	BRDG, APPL, INST, LANM, OSYS, **ADMN** (Ch. 9)
Use application programs to verify that devices can communicate across the interconnecting devices and remote connections	**ADMN** (Ch. 9), BRDG, APPL, INST, OSYS
Resolve any problems	INST, BRDG, PDP, OSYS, LANM, **ADMN** (Ch. 11)

Preparing for Software Installation

Task or Activity	**Refer To**
Determine which application programs will run in each device	APPL, **ADMN** (Ch. 8, 9, 10, 11)
Determine which interfaces and support programs are required for each application program and for each connection to another LAN segment, remote device, or network	APPL, **ADMN** (Ch. 8, 9, 10, 11)
Determine which programs to use for network problem isolation, problem resolution, and traffic evaluation	LANM, BRDG, TRPF, OSYS, PDP, APPL, **ADMN** (Ch. 9, 10, 11)
Choose the values of configuration and load parameters for each support and application program	APPL, LSP, LANM, BRDG, PDP, **ADMN** (Ch. 8, 9, 10, 11)
Write any programs required by your establishment and network	LANM, BRDG, TREF, ARF, APPL, LSP, **ADMN** (Ch. 9)

Preparing Programs for Hosts and Controllers

Task or Activity	**Refer To**
Copy programs and files from magnetic tape to disk files or libraries	APPL, LSP, OSYS, **ADMN** (Ch. 8, 9)
Prepare code statements or commands as input to a program preparation process	APPL, LSP, OSYS, **ADMN** (Ch. 8, 9)
Execute the program preparation process	APPL, **ADMN** (Ch. 8, 9)
Install, activate, and/or run the prepared program in the connecting device	APPL, **ADMN** (Ch. 8, 9)

Preparing Programs for Workstations

Task or Activity	Refer To
Decide whether the copies will reside on fixed disks or diskettes	APPL, **ADMN** (Ch. 9)
Decide how programs will be loaded into the computer	APPL, OSYS, LSP, BRDG, **ADMN** (Ch. 8, 9)
Determine which programs and files need to be on the same disk or diskette	APPL, OSYS, LSP, BRDG, PCLN, **ADMN** (Ch. 8, 9)
Determine what parameter values are required for each program	APPL, OSYS, LSP, BRDG, **ADMN** (Ch. 8, 9)
Format blank diskettes (to contain an operating system, if necessary)	OSYS, **ADMN** (Ch. 9)
Create or modify fixed disk directories	OSYS, BRDG, LANM, APPL, **ADMN** (Ch. 9)
Copy programs and files to the working diskettes or fixed disks	OSYS, APPL, **ADMN** (Ch. 9)
Change or create required system parameter files	OSYS, LSP, PCLN, APPL, **ADMN** (Ch. 9)
Modify or create program configuration parameter files	APPL, OSYS, PCLN, BRDG, LSP, **ADMN** (Ch. 9)
Modify or create AUTOEXEC.BAT and other batch load or command files	APPL, OSYS, BRDG, LANM, PCLN,, **ADMN** (Ch. 9)
Label working diskette copies	**ADMN** (Ch. 9)
Back up the contents of fixed disks onto diskettes or magnetic tapes	OSYS, **ADMN** (Ch. 9)
File and store original diskettes, fixed disk backups, and masters of the working diskettes in a safe place	**ADMN** (Ch. 9)
Create procedures for accessing and using programs and data files	APPL, BRDG, LANM, PCLN, **ADMN** (Ch. 9, 10)

Creating Your Establishment Problem Reporting and Resolution Procedure

Task or Activity	**Refer To**
Prepare instructions for reporting a network problem	**ADMN** (Ch. 11, 9)
Assign a person to contact to report the problem	**ADMN** (Ch. 11)
Indicate what information to provide to the person who answers the call	APPL, OSYS, PDP, LHI, LANM, **ADMN** (Ch. 11)
Prepare instructions for receiving and recording a problem report	**ADMN** (Ch. 11)
Determine whether and how to record reported information in a log or on a form	**ADMN** (Ch. 11)
Indicate what action the reporter of the problem is to take next	**ADMN** (Ch. 11)
Describe how to begin problem resolution	LANM, LHI PDP, APPL, **ADMN** (Ch. 11)
Determine what action network users are expected and allowed to take before reporting a problem	**ADMN** (Ch.11), APPL, OSYS
Decide who is responsible for what activities after a problem is reported	**ADMN** (Ch. 11)
Determine what activities you (the network administrator) participate in after a problem is reported	**ADMN** (Ch. 11), APPL, PDP, BRDG, LANM, LHI
List items and information required for problem resolution, and their locations (planning charts, spare components, procedures, documentation, and so on)	**ADMN** (Ch. 11), PDP, LANM, ADP, HMS, IPG, APPL, HDWR, LHI, INST, BRDG, TRPF, PCPS, OSYS
Prepare instructions for obtaining the materials	**ADMN** (Ch. 11)
Prepare instructions for updating charts and other documentation when resolving the problem results in a permanent change to the LAN segment or network configuration	**ADMN** (Ch. 11), IPG, PDP
Decide how to notify users that a portion of a LAN segment or network will be inoperative during problem resolution	PDP, LANM, OSYS
Decide how to notify users that they may see intermittent errors while the problem is being corrected	PDP, LANM, OSYS
Decide how you (the network administrator) are to be notified when the error information and procedures say to do so	**ADMN** (Ch. 11), APPL, PDP, LANM, LHI, BRDG, OSYS
Determine what information should be given to you when you are notified of an event	APPL, PDP, LANM, LHI, BRDG, OSYS
Determine what action you are to take when you are notified of an event	APPL, PDP, LANM, LHI, BRDG, OSYS
Determine what paperwork, information, materials, and instructions are required for obtaining outside assistance to resolve a problem	**ADMN** (Ch. 10, 11), APPL, HDWR, LANM, BRDG, PDP

List of Abbreviations

ACF	advanced communications function
AIX	Advanced Interactive Executive Operating System
ANSI	American National Standards Institute
APPC	Advanced Program-to-Program Communications
APPC/PC	Advanced Program-to-Program Communication for the IBM Personal Computer
API	Application Program Interface
APPN	Advanced Peer-to-Peer Networking
ASCII	American National Standard Code for Information Interchange
AEA	ASYNCH/ASCII Emulation Adapter
BASIC	Beginners All-Purpose Symbolic Instruction Code
BIOS	Basic Input/Output System
bps	bits per second
BSC	binary synchronous communication
CATV	community antenna television
CCB	command control block
CCTV	closed circuit television
CICS	Customer Information Control System
CPC	Communication Processor Card
CSMA/CD	carrier sense multiple access with collision detection
dB	decibel
DCAF	distributed console access facility
DEC	data communication equipment
DIA	Document Interchange Architecture
DISOSS	Distributed Office Support System
DLC	data link control
DOS	Disk Operating System
DSPU	downstream physical unit
DTE	data terminal equipment
EBCDIC	extended binary-coded decimal interchange code
EBI	Enhanced BIOS Interface
FDM	frequency-division multiplexing
HDLC	High-Level Data Link Control
I/O	input/output
ICF	Interactive Communications Feature
IEEE	Institute of Electrical and Electronics Engineers, Inc.
ISO	International Standards Organization
K	Kilo or 1024
KB	Kilobyte = 1024 bytes for processor storage (memory) size, otherwise = 1000 bytes
Kbps	Kilobits per second
LAN	local area network
LANACS	IBM Local Area Network Asynchronous Connection Server Program
LLC	logical link control
LTLW	IBM LAN to LAN Wide Area Network Program
LU	logical unit
MAC	medium access control
MAP	Manufacturing Automation Protocol
MB	Megabyte = 1024 KB = 1,048,576 bytes for processor storage (memory) size, otherwise = 1,000,000 bytes
Mbps	Million bits per second
MLT	Multiple Logical Terminals
MVS	Multiple Virtual Storage
NAU	network addressable unit
NAUN	nearest active upstream neighbor
NCP	Network Control Program
NETBIOS	Network Basic Input/Output System
NTRI	Network Token-Ring Interface
OS	Operating System
OSA	open systems architecture
OSI	open systems interconnection
PABX	private automatic branch exchange
PBX	private branch exchange
PC	personal computer
POST	power-on self-test
PSN	public switched network
PU	physical unit
RAM	random access memory
REM	ring error monitor

RF	radio frequency
RISC	reduced instruction set computer
ROM	read-only memory
RPL	remote program load
RT	RISC technology
RU	response unit, or request unit
SAA	System Application Architecture
SAP	service access point
SDLC	synchronous data link control
SNA	Systems Network Architecture
SNADS	Systems Network Architecture Distribution Services
SNI	SNA Network Interconnection
SPCS	Service Point Command Service
SRAM	shared or static random access memory
SSCP	System services control point
SSP	System Support Program
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	time-division multiplexing
TIC	Token-Ring Interface Coupler
TRA	Token-Ring Network Adapter Feature
VM	virtual machine
VSE	Virtual Storage Extended
VTAM	Virtual Telecommunications Access Method
WAN	wide area network

Glossary

This glossary defines the local area network terms and abbreviations used in this publication. It includes terms and definitions from the *IBM Dictionary of Computing (Information Processing, Personal Computing, Telecommunications, Office Systems, IBM-Specific Terms)*, SC20-1699.

- The symbol (A) identifies definitions from the *American National Dictionary for Information Processing Systems*, copyright 1982 by the Computer and Business Equipment Manufacturers Association (CBEMA).
- The symbol (I) identifies definitions from the *ISO Vocabulary-Information Processing* and *ISO Vocabulary-Office Machines*, developed by the International Organization for Standardization, Technical Committee 97, Subcommittee 1.
- The symbol (T) identifies definitions from draft international standards, draft proposals, and working papers in development by the International Organization for Standardization, Technical Committee 97, Subcommittee 1.

A

access unit. A wiring concentrator that allows multiple attaching devices access to the ring at a central point such as a wiring closet or in an open work area.

active monitor. In the IBM Token-Ring Network, a function in a single adapter that initiates the transmission of tokens and provides token error recovery facilities. Any active adapter on the ring has the ability to provide the active monitor function if the current active monitor fails.

adapter. The circuit card within an attaching device, and its associated software, that enable the device to communicate over a local area network.

Adapter Support Interface. The software used to operate IBM Token-Ring Network adapters in an IBM Personal Computer and provide a common interface to application programs.

alert. In the IBM LAN Manager, a notification appearing on the bottom line of any panel to indicate an interruption or a potential interruption in the flow of data around the local area network, or loss of LAN Manager function.

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

appendage. An application program routine provided to assist in handling a specific occurrence.

application program. A program written for or by a user that applies to the user's work. A program used to connect and communicate with stations in a network, enabling users to perform application-related activities.

architecture. The description of the logical structure, formats, protocols, and operational sequence for transmitting information through, and controlling the configuration and operation of, a network.

ASCII (American National Standard Code for Information Interchange). The standard code, using a coded character set consisting of 7-bit coded characters (8-bit including parity check), used for information interchange among data processing systems, data communication systems, and associated equipment. The ASCII set consists of control characters and graphic characters. (A)

asynchronous (ASYNCH). Without regular time relationship; unexpected or unpredictable with respect to the execution of program instructions.

asynchronous data transfer. A physical transfer of data to or from a device that occurs without a regular or predictable time relationship following execution of an I/O request.

attach. To participate in the data passing protocol of the ring.

attaching device. Any device that is physically connected to a network and can communicate over the network.

attachment feature. A feature that can be added to enhance the capability, storage capacity, or performance of a product, but is not essential for its basic work; for example, an adapter that allows a device to attach to a network.

attenuation. A decrease in magnitude of current, voltage, or power of a signal in transmission between points. It is expressed in decibels or nepers.

B

backbone LAN segment. In a local area network multiple LAN segment configuration, a high-speed, centrally located LAN segment to which other LAN segments are connected by means of bridges.

bandwidth. The difference, expressed in Hertz, between two limiting frequencies of a band. For example, the transmission by telephone requires a bandwidth of about 3000 Hertz (3 kHz).

baseband. A frequency band that uses the complete bandwidth of a transmission medium.

baseband local area network. A local area network in which information is encoded, multiplexed, and transmitted without modulation of a carrier. The IBM Token-Ring Network is an example.

beacon. A frame repeatedly sent by an adapter indicating a serious network problem, such as a broken cable. To send such a frame.

BIOS. (Basic input/output system) In an IBM personal computer, microcode that controls basic hardware operations such as interactions with diskette drives, fixed disk drives, and the keyboard.

bit error rate. A measure of the quality of a circuit or system; it is expressed as the number of erroneous bits or characters in a sample, frequently taken per 100,000 characters.

bridge. A functional unit that connects two LAN segments that use the same logical link control (LLC) procedures but may use different medium access control (MAC) procedures. A bridge consists of the bridge computer, two adapters and their cables, and the Bridge Program.

bridge ID. The bridge label combined with the adapter address of the adapter connecting the bridge to the LAN segment with the lowest LAN segment number; it is used by the Bridge Program automatic single-route broadcast function.

bridge label. A two-byte hexadecimal number that you can assign to each bridge. See bridge ID.

bridge number. The identifier that distinguishes parallel bridges (that is, bridges spanning the same two LAN segments).

broadband. A frequency band divisible into several narrower bands so that multiple transmissions or different kinds of transmissions (voice, video, and data transmission) can occur at the same time. Synonymous with wideband. See also baseband.

broadband local area network. A local area network in which information is encoded, multiplexed, and transmitted with modulation of carriers. The IBM PC Network Broadband is an example.

broadcast. Simultaneous transmission of data to more than one destination.

broadcast address. A frame destination address of all 1s, to indicate that all stations on a LAN segment or network should receive the frame. Synonymous with all-stations address.

broadcast topology. A network topology in which all stations are capable of simultaneously receiving a signal transmitted by any other station on the network.

buffer. (1) A routine or storage used to compensate for a difference in rate of flow of data, or time of occurrence of events, when transferring data from one device to another. (A) (2) A portion of storage used to hold input or output temporarily.

bus. (1) In a processor, a physical facility on which data is transferred to all destinations, but from which only addressed destinations may read in accordance with appropriate conventions. (I) (2) A computer configuration in which processors are interconnected in series. (3) One or more conductors used for transmitting signals or power. (A)

bus network. A network configuration that provides a bidirectional transmission facility to which all stations are connected. A sending station transmits in both directions to the ends of the bus. All stations in the path copy the message as it passes.

bypass. To eliminate a component from a network by allowing the data to flow in a path around it.

C

cable loss. The amount of RF signal attenuation caused by the coaxial cable. This attenuation is a function of frequency and cable distance. High frequencies have a greater loss than low frequencies and follow a logarithmic function. Cable losses are usually calculated for the highest frequency carried on the cable.

cable segment. A section of cable between components or devices on the network. May be a single patch cable, multiple patch cables connected together, or a combination of building cable and patch cables connected together.

cable tilt. The difference in cable attenuation between the higher and lower frequencies. Tilt causes a reduction in the level of an RF sweep signal passing through a cable as the signal varies from low to high frequency. A specific fixed length of cable and a fixed frequency range produce a fixed amount of tilt.

carrier. On broadband networks, a continuous frequency signal that can be modulated with an information-carrying signal.

carrier sense multiple access with collision detection (CSMA/CD). (1) A transmission technique used to avoid data collisions on a network cable. (2) The protocol used with this technique requires carrier sense. A transmitting station that detects another signal while transmitting, stops sending, sends a jamming signal, and waits for a variable time period before trying to transmit again.

channel-attached. (1) Pertaining to attachment of devices directly by data channels (I/O channels) to a computer. (2) Pertaining to devices attached to a controlling unit by cables, rather than by telecommunication lines. (3) Synonymous with local, locally attached.

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.

coaxial cable. A cable consisting of one conductor, usually a small copper tube or wire, within and insulated from another conductor of larger diameter, usually copper tubing or copper braid.

communication link. (1) The assembly of parts of two data terminal equipment that are controlled by a link protocol, and the interconnecting data circuit, that enable data to be transferred from a data source to a data sink. (I) (2) Synonymous with data link.

Note: A communications link includes the physical media of transmission, the protocol, and associated devices and programs — it is both logical and physical.

component. Any part of a network other than an attaching device, such as an IBM 8228 Multistation Access Unit.

configuration. (1) The arrangement of a computer system or network as defined by the nature, number, and the chief characteristics of its functional units. The term may refer to a hardware or a software configuration. (I) (A) (2) The devices and programs that make up a system, subsystem, or network.

configuration file. The collective set of item definitions that describe a configuration.

continuous carrier. On broadband networks, a condition in which a carrier signal is being constantly broadcast on a given frequency. No further information can be modulated on that frequency.

control block. A storage area used by a computer program to hold control information. (I) (A)

controller. A unit that controls input/output operations for one or more devices.

controlling link. The reporting link between a bridge and a network manager program that is authorized to change bridge configuration parameters and to disable and enable certain bridge functions.

conversation. The logical connection between a pair of transaction programs for serially sharing a session between type 6.2 logical units from transaction to transaction. While a conversation is active, it has exclusive use of an LU-LU session as delimited by a distinct bracket; successive conversations may use the same session.

coupler. A device that connects a modem to a telephone network.

CSMA/CD. See carrier sense multiple access with collision detection.

customize. The process of defining and activating a configuration and changing system parameters to meet user requirements.

D

data grade. 150-ohm shielded twisted-pair media that meets IBM's specifications for types 1, 2, 6, 8 and 9 cable.

datagram. A particular type of information encapsulation at the network layer of the adapter protocol for NETBIOS. No explicit acknowledgment for the information is sent by the receiver. Instead, transmission relies on the "best effort" of the link layer.

data link. (1) The assembly of parts of two data terminal equipment that are controlled by a link protocol, and the interconnecting data circuit, that enable data to be transferred from a data source to a data sink. (I) (2) The interconnecting data circuit and the link protocol between two or more equipments; it does not include the data source or data sink.

Note: A data link includes the transmission physical media, the protocol, and associated devices and programs — it is both logical and physical.

data link layer. (1) In Open Systems Interconnection Architecture, the layer that provide services to transfer data over a branch between open systems. (I) (2) The layer in Open Systems Architecture that provides the functions and procedures used to establish, maintain, and release data link connections between elements of the network.

data link level. In the hierarchical structure of a data station, the conceptual level of control or processing logic between high level logic and the data link. The data link level performs such functions as inserting transmit bits and deleting receive bits; interpreting address and control fields; generating, transmitting, and interpreting commands and responses; and computing and interpreting frame check sequences.

data sink. (1) The functional unit that accepts transmitted data. (T) (2) The part of a data terminal equipment (DTE) that receives data from a data link.

data source. (1) The functional unit that originates data for transmission. (I) (2) The part of a data terminal equipment (DTE) that enters data into a data link.

decibel (dB). A unit that expresses the ratio of two power levels on a logarithmic scale.

default. Pertaining to an attribute, value, or option that is assumed when none is explicitly specified.

delimiter. A bit pattern that defines the beginning and end of a frame or token on a network. A delimiter is not part of the character string it delimits.

designated bridge. A bridge in a network using automatic single-route broadcast that forwards single-route broadcast frames.

device. An input/output unit such as a terminal, display, printer, host, or controller.

diagnostics. Modules or tests used by computer users and service personnel to isolate and identify hardware problems.

digital. (1) Pertaining to data in the form of digits. (A) (2) Contrast with analog.

disk image. A representation of a disk or diskette containing files and programs. The image resides in computer storage and is used by the computer as though it were a physical disk or diskette.

Disk Operating System (DOS). (1) A program that controls the operation of an IBM Personal Computer or Personal System/2 computer and the execution of application programs. (2) An operating system for personal computers that use disks and diskettes for auxiliary storage of programs and data.

DLC protocol. In SNA, a set of rules used by two nodes on a data link to accomplish an orderly exchange of information.

downstream. (1) On a ring network, in the direction of data flow. (2) Toward the destination of transmission.

downstream PU (DSPU). The next physical unit in the direction of data flow or toward the destination of transmission.

dump. (1) Computer printout of storage. (2) To write the contents of all or part of main, auxiliary, or virtual storage to an external medium as a safeguard against errors or in connection with debugging. (3) Data that have been dumped. (I) (A)

E

enabled. Active, operational, and can receive frames from the network. (Servers and functional addresses may be enabled by programs running on a local area network.)

enterprise. A business or organization that consists of two or more physical sites separated by a public right-of-way or a geographical distance. Contrast with establishment.

establishment. A user's premises that does not extend across public rights of way (for example, a single office building, warehouse, or campus).

F

fault domain. In IBM Token-Ring Network problem determination, the portion of a ring that is involved with an indicated error.

filter. A device or program that separates data, signals, or material in accordance with specified criteria. (A)

formatted diskette. A diskette on which track and sector control information has been written and which may or may not contain data.

Note: A diskette must be formatted before it can receive data.

frame. The unit of transmission in some local area networks. It includes delimiters, control characters, information, and checking characters. In an IBM Token-Ring Network, a frame is created from a token when the token has data appended to it.

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

frequency-division multiplexing (FDM). Division of a transmission facility into two or more channels by splitting the frequency band transmitted by the channel into narrower bands, each of which constitutes a distinct channel. See also time-division multiplexing.

frequency pair. The two frequency ranges used for transmitting and receiving information by an IBM PC Network Broadband adapter.

G

gateway. A device and its associated software that interconnect two networks that use different network architectures or protocols.

H

hard error. A serious error on the network that requires that the network be reconfigured or that the source of the error be removed before the network can resume reliable operation.

"hello" message. A message used by automatic single-route broadcast to detect what bridges enter and leave the network and to reset single-route broadcast parameters accordingly. The root bridge sends a "hello" message on the network every two seconds.

hierarchical network. A multiple-LAN segment network configuration providing only one path through intermediate rings between source LAN segments and destination LAN segments. Contrast with mesh network.

higher level. In the hierarchical structure of a data station, the conceptual level of control or processing logic, above the data link level, that determines the performance of data link level functions such as device control, buffer allocation, and station management.

high-level data link control (HDLC). In data communication, the use of a specified series of bits to control data links in accordance with the International Standards for HDLC: ISO 3309 Frame Structure and ISO 4335 Elements of Procedure.

hop count. The number of bridges through which a frame has passed on the way to its destination. For some IBM bridge programs, hop count applies to broadcast and single-route broadcast frames. For other IBM bridge programs, hop count applies only to broadcast frames. Hop count does not affect non-broadcast frames passing through bridges.

hop count limit. The maximum number of bridges through which a frame may pass on the way to its destination.

host. In a computer network, a computer that provides end users with services such as computation and databases and that usually performs network control functions. (T) Synonymous with host computer and host processor.

I

insert. In the IBM Token-Ring Network, to make an attaching device an active part of the ring.

interface. (1) A shared boundary between two functional units, defined by functional characteristics, common physical interconnections characteristics, signal characteristics, and other characteristics as appropriate. (I) (2) A shared boundary. An interface may be a hardware component to link two devices or accessed by two or more computer programs. (A) (3) Hardware, software, or both, that links systems, programs, or devices.

Note: This concept involves specification of the connection of two functional units that have different functions.

interrupt. (1) A suspension of a process, such as execution of a computer program, caused by an external event and performed in such a way that the process can be resumed. (A) (2) To stop a process in such a way that it can be resumed. (3) The means of transferring processing control to and from a host processor and an adapter installed in the host processor.

L

LAN segment. Any portion of a local area network (for example, a single ring or bus) that can operate independently but is connected to the establishment network via bridging products.

layer. (1) In a network architecture, a group of services, functions, and protocols that is complete from a conceptual point of view, that is one of a set of hierarchically arranged groups, and that extends across all systems that conform to the network architecture. (T) (2) In SNA, a grouping of related functions that are logically separate from the functions in other layers. Implementation of the functions in one layer can be changed without affecting functions in other layers.

link. The combination of the link connection and the link stations that joins adjacent nodes in a network; for example: (1)a System/370 or System/390 channel and its associated protocols, (2) a serial-by-bit connection under the control of synchronous data link control (SDLC). Synonymous with data link.

Note: A link connection is the physical medium of transmission; for example, a telephone wire or a microwave beam. A link includes the physical medium of transmission, the protocol, and associated communication devices and programming; it is both logical and physical.

link station. The combination of hardware and software that allows a node to attach to, and provide control for, a link.

LLC protocol. In a LAN, the protocol that governs the assembling of transmission frames and their exchange between data stations independently of the medium access control protocol.

lobe. (1) In the IBM Token-Ring Network, the section of cable (which may consist of several segments) that connects an attaching device to an access unit. (2) In a star-wired ring network, two pairs of conductors that provide separate send and receive paths between a wiring concentrator and a network port or connection point.

lobe receptacle. In the IBM Token-Ring Network, an outlet on an access unit for connecting a lobe.

local. (1) Pertaining to a device accessed directly without use of a telecommunication line. (2) Synonymous with channel-attached. (3) Contrast with remote.

local area network (LAN). A network in which communications are limited to a moderate-sized geographic area such as a single office building, warehouse, or campus and which do not generally extend across public rights-of-way. This network is comprised of the equipment and program products used to connect two or more devices so that they can share hardware and software resources.

local bridge. A function of IBM bridge programs that allows a single bridge computer to connect two LAN segments (without using a telecommunication link).

logical link control (LLC) protocol. In a local area network, the protocol that governs the assembling of transmission frames and their exchange between data stations independently of the medium access control protocol. (T)

logical link control (LLC) sublayer. One of two sublayers of the ISO Open Systems Interconnection data link layer (which corresponds to the SNA data link control layer), proposed for local area networks by the IEEE Project 802 Committee on Local Area Networks and the European Computer Manufacturers Association (ECMA). It includes those functions unique to the particular link control procedures that are associated with the attached node and are independent of the medium; this allows different logical link protocols to coexist on the same network without interfering with each other. The LLC sublayer uses services provided by the Medium Access Control (MAC) sublayer and provides services to the network layer.

logical unit (LU). A port through which an end user accesses the SNA network in order to communicate with another end user and through which the end user accesses the functions provided by system services control points (SSCPs). An LU can support at least two sessions—one with an SSCP, and one with another logical unit—and may be capable of supporting many sessions with other logical units.

LU type 6.2. A type of LU that supports sessions between two applications in a distributed data processing environment using the SNA general data stream, which is a structured-field data stream, or a user-defined data stream. LU 6.2 sessions provide communication between two type 5 nodes, a type 5 and a type 2.1 node, and two type 2.1 nodes. For example, an application program running on CICS/VS communicating with an application program running on another CICS/VS, a DISOSS/370 application on CICS/VS communicating with a Displaywriter System, or an application program running on a System/36 or 38.

M

MAC protocol. In a LAN, the protocol that governs communication on the transmission media without concern for the physical characteristics of the medium, but taking into account the topological aspects of the network, in order to enable the exchange of data between data stations. (T)

medium. A physical carrier of electrical or optical energy, such as a cable.

medium access control (MAC) frame. In the IBM Token-Ring Network: (1) An address resolution request frame that has the unique part of a destination address and an "all rings" address. A sender issues this request to determine the ring where the destination station is located and whether the node is active. (2) Response from an active destination node to the requesting source node, providing the source node with the complete address and ring number of the destination node.

medium access control (MAC) sublayer. One of two sublayers of the ISO Open Systems Interconnection data link layer proposed for local area networks by the IEEE Project 802 Committee on Local Area Networks and the European Computer Manufacturers Association (ECMA). It provides functions that depend on the topology of the network and uses services of the physical layer to provide services to the logical link control (LLC) sublayer.

mesh network. A multiple-LAN segment network configuration providing more than one path through intermediate LAN segments between source LAN segments and destination LAN segments. Contrast with hierarchical network.

microcode. (1) One or more microinstructions. (2) A code, representing the instructions of an instruction set, that is implemented in a part of storage that is not program-addressable. (3) To design, write, and also test one or more microinstructions.

Note: The term microcode represents microinstructions used in a product as an alternative to hard-wired circuitry to implement functions of a processor or other system component. The term microprogram means a dynamic arrangement of one or more groups of microinstruction for execution to perform a certain function.

migrate. To move to a changed operating environment, usually to a new release or version of a program, system, or device.

modem (modulator/demodulator). A device that converts digital data from a computer to an analog signal that can be transmitted in a telecommunication line, and converts the analog signal received to data for the computer.

modulation. (1) Varying of the amplitude, frequency, or phase of a signal. (2) The process by which a characteristic of a signal is varied according to a characteristic of another signal.

N

NAUN. Nearest active upstream neighbor. For any attaching device on a ring, the device that is sending frames or tokens directly to it.

network. A signal path connecting input/output devices to a system. A network may consist of multiple LAN segments connected together with bridging products. See ring (network).

network addressable unit (NAU). In SNA, a logical unit, a physical unit, or an SSCP. The NAU is the origin or the destination of information transmitted by the path control network.

network administrator. A person who manages the use and maintenance of a network.

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 manager. A program or group of programs that is used to monitor, manage, and diagnose the problems of a network.

no carrier. On broadband networks, a condition in which a carrier signal is not being broadcast on a given frequency. In the absence of such a carrier, no information can be modulated on that frequency.

node. An endpoint of a link or a junction common to two or more links in a network. Nodes can be processors, controllers, or workstations. Nodes vary in routing and other functional capabilities.

noise. (1) A disturbance that affects a signal and that can distort the information carried by the signal. (T) (2) Random variations of one or more characteristics of any entity such as voltage, current, or data. (A) (3) A random signal of known statistical properties of amplitude, distribution, and spectral density. (A) (4) Loosely, any disturbance tending to interfere with normal operation of a device or system. (A) (5) In acoustics, any undesired sound. See ambient noise, background noise, burst noise, impulsive noise. (6) See reference noise.

non-broadcast frame. A frame containing routing information specifying which bridges are to forward it. A bridge will forward a non-broadcast frame only if that bridge is included in the frame's routing information.

nonswitched link. (1) A connection between two nodes that does not have to be established by dialing. Contrast with switched link. (2) A telecommunications line on which connections do not have to be established by dialing. Synonymous with leased line.

notification. A message that describes a condition for which a program requires a reply from its caller, or a default reply is sent to the program.

O

open. (1) To make an adapter ready for use. (2) A break in an electrical circuit. (3) To make a file ready for use.

open systems architecture (OSA). A model that represents a network as a hierarchical structure of layers of functions; each layer provides a set of functions that can be accessed and that can be used by the layer above it.

Note: Layers are independent in the sense that implementation of a layer can be changed without affecting other layers.

open systems interconnection (OSI). (1) The interconnections of open systems in accordance with specific ISO standards. (T) (2) The use of standardized procedures to enable the interconnection of data processing systems.

Note: OSI architecture establishes a framework for coordinating the development of current and future standards for the interconnection of computer systems. Network functions are divided into seven layers. Each layer represents a group of related data processing and communication functions that can be carried out in a standard way to support different applications.

open systems interconnection (OSI) architecture. Network architecture that adheres to a particular set of OSI standards that relates to open systems interconnection. (T)

operating system (OS). Software that controls the execution of programs. An operating system may provide services such as resource allocation, scheduling, input/output control, and data management. (I) (A)

output device. A device in a data processing system by which data may be received from the system. (I) (A)

P

pacing. A technique by which a receiving station controls the rate of transmission of a sending station to prevent overrun.

passive loss. The total attenuation caused by all the passive components in a network.

parameter. (1) A variable that is given a constant value for a specified application and that may denote the application. (I) (A) (2) An item in a menu for which the user specifies a value or for which the system provides a value when the menu is interpreted. (3) Data passed between programs or procedures.

path. (1) In a network, a route between any two nodes. (T) (2) The route traversed by the information exchanged between two attaching devices in the network.

path cost. A value, maintained by each bridge, that indicates the relative length of the path between the root bridge and another bridge.

path trace. A function that may be requested of a bridge by a received frame. The request is for a record of the bridges through which the frame has passed.

physical layer. In Open Systems Interconnection Architecture, the layer that provides services to transmit bits over a branch between open systems. (T)

physical unit (PU). The component that manages and monitors the resources (such as attached links and adjacent link stations) of a node, as requested by an SSCP via an SSCP-PU session. Each node of an SNA network contains a physical unit.

private branch exchange (PBX). An automatic or manual private telephone exchange for transmission of calls to and from the public telephone network.

processor. (1) In a computer, a functional unit that interprets and executes instructions. (I) (A) (2) The functional unit that interprets and executes instructions.

protocol. (1) A set of semantic and syntactic rules that determine the behavior of functional units in achieving communication. (2) In SNA, the meanings of and sequencing rules for requests and responses used for managing the network, transferring data, and synchronizing the states of network components.

public switched network (PSN). Any switching system that provides a circuit switched to many customers. In the USA, there are four: Telex, TWX, telephone, and Broadband Exchange.

R

radio frequency (RF). The rate of radio signal oscillation, expressed in hertz.

RAM paging. RAM paging is a technique that allows the computer software to access all the RAM on the adapter, without having to map the entire shared RAM into the computer's memory map. The shared RAM on the adapter is paged into the computer's memory map one area at a time.

random access memory (RAM). A computer's storage area into which data may be entered and retrieved in a nonsequential manner.

read-only memory (ROM). A computer's storage area whose contents cannot be modified by the user except under special conditions.

remote. (1) Pertaining to a system program, or device that is accessed through a telecommunication line. (2) Contrast with local.

remote bridge. A function of a bridge program that allows two bridge computers to use a telecommunication link to connect two LAN segments.

remove. To make an attaching device inactive on a LAN segment. To stop an adapter from participating in data passing on the network.

resident. Pertaining to computer programs or data as long as they remain in computer memory or on a particular storage device.

resource. (1) People, equipment, or material used to perform a task or a project. (2) Any facility of a computing system or operating system required by a job or task, and including main storage, input/output devices, processing unit, data sets, and control or processing programs.

response time. The elapsed time between the end of an inquiry or demand on a computer system and the beginning of the response; for example, the length of time between an indication of the end of an inquiry and the display of the first character of the response at a user terminal. (I) (A)

return code. A hexadecimal value provided by hardware or software to indicate the result of an action.

ring (network). A network configuration consisting of a series of nodes or attaching devices connected by unidirectional transmission links to form a closed path. Multiple rings may be connected together by means of bridges to form a single network.

ring error monitor (REM). A program that compiles error statistics reported by adapters on a network, analyzes the statistics to determine a probable cause of the errors, sends reports to network management programs, and updates network status conditions.

ring network. A network configuration in which devices are connected by unidirectional transmission links to form a closed path. See also star/ring network, token-ring network.

Ring Diagnostic. In the IBM Token-Ring Network, software to be run in a workstation that provides the user information regarding the status of the ring.

ring sequence. The order in which devices are attached on a ring network.

ring status. The condition of a ring.

root bridge. The bridge in a network using automatic single-route broadcast that sends the "hello" message on the network every two seconds. Automatic single-route broadcast uses the message to detect when bridges enter and leave the network, and to change single-route broadcast parameters accordingly.

routing. The assignment of the path by which a message will reach its destination.

S

server. (1) A device, program, or code module dedicated to specific functions on a network. (2) On a local area network, a data station that provides facilities to other data stations, for example, a file server, a print server, a mail server, (T)

service access point (SAP). A logical point made available by an adapter where information can be received and transmitted.

session. (1) In a network architecture, an association of facilities necessary for establishing, maintaining, and releasing connections for communications between stations. (T) (2) The period of time during which a user of a terminal can communicate with an interactive system, usually elapsed time between logon and logoff. (3) A logical connection between two network addressable units (NAUs) that can be activated, tailored to provide various protocols, and deactivated as requested. The session-activation request and response can determine options relating to such things as the rate and concurrency of data exchange, the control of contention and error recovery, and the characteristics of the data stream.

session layer. In Open Systems Interconnection Architecture, the layer that provides the services that organized and synchronize communication between functional units in different open systems, located in the presentation layer. (T)

Note: These services establish, maintain, and terminate communication.

shared RAM. Random access storage on the adapter that is shared by the computer in which the adapter is installed.

single-route broadcast. The forwarding of specially designated broadcast frames only by bridges which have single-route broadcast enabled. If the network is configured correctly, exactly one copy of a single-route broadcast frame will be delivered to every LAN segment in the network. Also called limited broadcast.

signal. (1) A time-dependent value attached to a physical phenomenon for conveying data. (I) (A) (2) A variation of a physical quantity, used to convey data. (I) (A) (3) An SNA command used to request a break in data flow. (4) See also carrier.

single-route broadcast. The forwarding of specially designated broadcast frames only by bridges which have single-route broadcast enabled. Also called limited broadcast.

SNA Distribution Services (SNADS). Service transaction programs that allow processors and workstations to asynchronously exchange files and documents.

SNA network. In SNA, the part of a user-application network that conforms to the formats and protocols of Systems Network Architecture. It enables reliable transfer of data among end users and provides protocols for controlling the resources of various network configurations. The SNA network consists of network addressable units (NAUs), boundary function components, and the path control network.

soft error. (1) An intermittent error on a network that requires retransmission. The adapters are able to retransmit the data that had the difficulty and communication continues. (2) An error on a network that can impair the network's performance but does not, by itself, affect its reliability. If the number of soft errors reaches the ring error limit, reliability is affected.

stand-by bridge. A bridge in a network using automatic single-route broadcast that does not forward single-route broadcast frames. A stand-by bridge is a parallel bridge or is in a parallel path between two LAN segments.

star network. A radial, or star-like, configuration of nodes connected to a central controller or computer in which each node exchanges data directly with the central node.

Note: Examples are the network topologies used in computerized branch exchanges (CBXs) and in private branch exchanges (PBXs).

star-wired ring. A ring network with unidirectional transmission laid out in such a way that several data stations are grouped and connected to the network by means of attaching units. (T)

Note: This configuration allows attachment and removal of data stations without disrupting network operation.

station. (1) One or more devices that provide one of the input/output points of a network. See attaching device. (2) An input or output point of a system that uses telecommunication facilities; for example, one or more systems, computers, terminals, devices, and associated programs at a particular location that con send or receive data over a telecommunication line.

subsystem. A secondary or subordinate system, or programming support, usually capable of operating independently of or asynchronously with a controlling system.

support program. A program that provides the necessary functions or resources for the correct operation of a functional unit (such as an adapter).

switched link. A link between two nodes that is established by dialing. Contrast with nonswitched link.

switched major node. In VTAM, an SNA major node whose minor nodes are physical units (PUs) and logical units (LUs) attached by switched SDLC links.

synchronous. (1) Pertaining to two or more processes that depend on the occurrences of a specific event such as common timing signal. (I) (A) (2) Occurring with a regular or predictable time relationship.

Synchronous Data Link Control (SDLC). A discipline conforming to subsets of the Advanced Data Communications 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)

system services control point (SSCP). A control point within a SNA network for managing the configuration, coordinating network operator and problem determination requests, and providing directory services and other session services for end users of a network.

system support program. Programs that manage the running of other programs and the operation of associated devices, such as the display station and printer.

T

telecommunications link. (1) The portion of a data circuit external to a data-circuit terminating equipment (DCE) that connects the DCE to a data switching exchange (DSE), that connects a DCE to one or more other DCEs, or that connects a DSE to another DSE. (T) (2) Any physical medium, such as a wire or microwave beam, that is used to transmit data.

Note: A telecommunications link is the physical medium, for example, a telephone wire, a microwave beam. A data link includes the physical medium of transmission, the protocol, and associated devices and programs; it is both logical and physical.

telephone twisted-pair. One or more twisted pairs of copper wire in the unshielded voice-grade cable commonly used for connecting a telephone to it wall jack.

threshold. In an IBM bridge program, refers to a value set for the number of frames (per 10,000 or per minute) that can be lost before the bridge program counts a "threshold exceeded" occurrence in the bridge Performance Statistics, and sends a notification to any network manager program that has requested such reports.

tilt compensation. The attenuation added to a network to provide equal attenuation at both the higher and lower frequencies.

time-division multiplexing (TDM). Division of a transmission facility into two or more channels to several different information channels, one at a time. See also frequency-division multiplexing.

token. A sequence of bits, signifying permission to transmit, passed from one device to another along the network. When the token has data appended to it, the token becomes a *frame*.

token passing. The process by which a local area network adapter captures a token; inserts a message, addresses, and control information; changes the bit pattern of the token to the bit pattern of a frame; transmits the frame; removes the frame from the LAN segment when it has made a complete circuit; generates another token; and transmits the token on the LAN segment where it can be captured by the next network adapter that is ready to transmit.

token-ring network. A network with a ring topology that passes tokens from adapter to adapter.

topology. The physical, geometrical layout of cable to connect devices in a network.

transaction. An exchange between (1) a workstation and a program, (2) two workstations, or (3) two programs, that accomplishes a particular action or result; for example, the entry of a customer's deposit and the updating of the customer's balance.

transaction program. A program that processes transactions in an SNA network. There are two kinds of transaction programs: application transaction programs and service transaction programs. See also conversation.

transmission medium. The physical medium that conveys data between data stations, for example, twisted pair wire, optical fiber, coaxial cable. (T)

transmit. To send information from one place for reception elsewhere. (A)

tree network. A network in which there is exactly one path between any two nodes. (T)

U

upstream. On a ring network, the direction opposite that of data flow or toward the source of transmission.

V

virtual machine. A functional simulation of a computer and its associated devices. Each virtual machine is controlled by a suitable operating system. For example, VM/370 controls concurrent execution of multiple virtual machines on a single System/370 or System/390 host.

voice grade channel. A data communications channel suitable for transmission of speech, digital data, or analog data, or for facsimile telegraphy, usually with a frequency range of about 300 to 3000 Hz.

voice-grade telephone line. A telephone line that is normally used for transmission of voice communication. The line requires a modem for data communication.

W

wide area network (WAN). A network that provides communication services to a geographic area larger than that served by a local area network.

wire fault. An error condition caused by a break in the wires or a short circuit between the wires or shield in a segment of cable.

wiring concentrator. A lobe concentrator that allows multiple attaching devices access to the ring at a central point. See access unit.

working disk(ette). A computer fixed disk or diskette to which files are copied from an original diskette for use in daily operation, to protect the original from damage.

workstation. A terminal or microcomputer, usually one that is connected to a mainframe or to a network, at which a user can perform applications (IBM Personal Computers and IBM Personal System/2 computers are workstations).

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