
Chapter 1. Understanding the IBM Token-Ring Network

A Local Area Network (LAN), such as the IBM Token-Ring Network, allows computer systems in the same building or group of buildings (which we call an *establishment*) to exchange information electronically. As small computers have moved into the workplace to perform functions previously done either by centralized computer systems or by hand, electronic transfer of information from system to system has become the major challenge of the data processing industry. A LAN should have the following characteristics if it is to improve the exchange of information among the computer systems in an establishment:

- The network should transmit data at a rapid rate.
- The network should serve the entire establishment with many types of devices, unless the establishment crosses a public right-of-way. Because crossing a public right-of-way requires regulatory approval, existing public utilities such as telephone lines are ordinarily used in such cases.
- The network must be easily restructured to meet the rapidly changing communications needs within establishments.
- The network must be highly reliable.
- The network must have high availability.
- The network must be serviceable.
- The network should permit attachment by all devices which require access to the network.

The IBM Token-Ring Network has been carefully designed to meet these requirements.

IBM Token-Ring Network Operation

ring. A network configuration where a series of devices are connected by unidirectional transmission links to form a closed path.

attaching device. Any device that is physically connected to a network and can communicate over the network.

adapter. In a LAN, within a communicating device, a circuit card that, with its associated software and/or microcode, enables the device to communicate over the network.

token. A sequence of bits passed from one device to another on the token-ring network that signifies permission to transmit over the network. It consists of a starting delimiter, an access control field, and an end delimiter. The access control field contains a bit that indicates to a receiving device that the token is ready to accept information. If a device has data to send along the network, it appends the data to the token. When data is appended, the token becomes a frame.

frame. The unit of transmission in some LANs, including the IBM Token-Ring Network and the IBM PC Network. It includes delimiters, control characters, information, and checking characters. On a token-ring network, a frame is created from a token when the token has data appended to it. On a token bus network (IBM PC Network), all frames including the token frame contain a preamble, start delimiter, control address, optional data and checking characters, end delimiter, and are followed by a minimum silence period.

baseband system. A data transmission system in which information is encoded, multiplexed, and transmitted without modulation of a carrier.

The IBM Token-Ring Network is a star-wired *ring* that allows you to connect up to 260 *attaching devices* (printers, processors, controllers) per ring through specially designed *adapters* installed in the attaching devices. The attaching device interfaces with the adapter to use the ring for sending and receiving data. The attaching device tells the adapter that it wants to send a message to another attaching device. The adapter places the message, the sender's address, and the recipient's address on a *token* circulating around the ring. The token then becomes a *frame*.

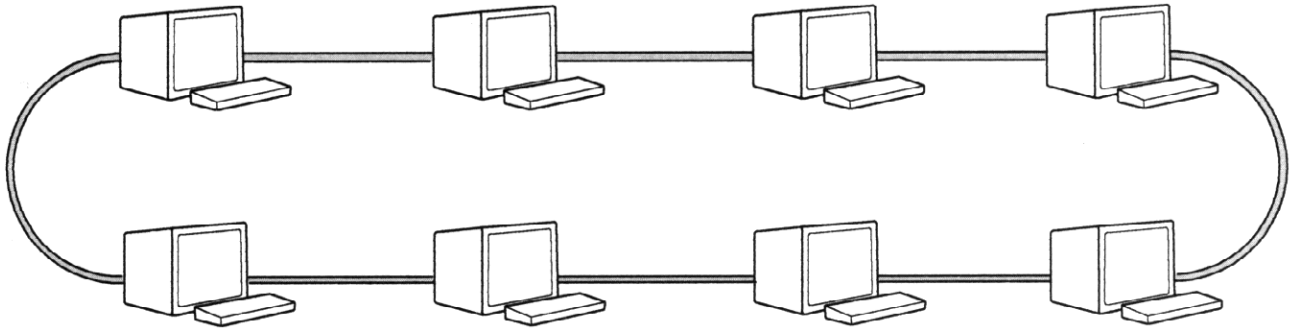
The recipient's address tells each adapter on the ring whether or not the message contained on the frame is intended for it. If it is, the adapter passes the information on the frame to its attaching device and indicates on the frame that the message has been received. Then the frame continues around the ring until it returns to the adapter that put the information on it. The adapter releases a new token on the ring.

The IBM Token-Ring Network is a *baseband system*. Messages are transmitted and received at a rate of either 4 or 16 megabits per second (Mbps). The data rate at which a single ring operates is determined by the data rate of the adapters in the attaching devices. All attaching devices on a single ring must have adapters that operate at the same data rate. All normal network operations are performed without user intervention once the message has been directed to the adapter. The operator of the attaching device does not have to be aware of routing and protocol procedures.

The Serially Wired Ring

work area. An area in which terminal devices (such as displays, keyboards, and printers) are located. Access units may also be located in work areas.

A serially wired ring like the one in the following figure presents problems in expansion, reconfiguration, and reliability. Because all *work areas* are wired into the ring path, installing a new workstation requires new cabling. Removing workstations due to changing needs or operational problems is equally complex. Any disabling error in the operation of the network affects all users and cannot be easily bypassed while the problem is being repaired. Since there is no central point where all the wiring meets, problems are distributed evenly around the ring, and service personnel are forced to walk around the ring to find them.



The Star-Wired Ring

wiring concentrator. A unit that allows multiple attaching devices access to the ring at a central point such as a wiring closet or in an open work area. A star-wired ring consists of one or more concentrators connected together to form a ring.

A star-wired ring retains the logical flow of data of a serially wired ring while avoiding some of the serially wired ring's limitations. A star-wired ring places a *wiring concentrator* (called an access unit) on the ring to provide access to the ring for a number of attaching devices at a single point even though the devices may be scattered about the establishment.

lobe. In the IBM Token-Ring Network, the section of cable (which may consist of several cable segments) that connects an attaching device to an access unit.

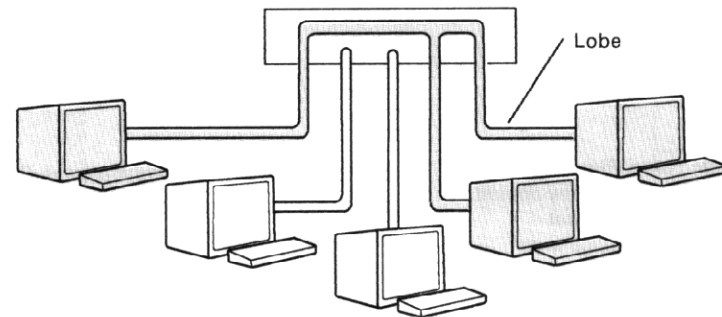
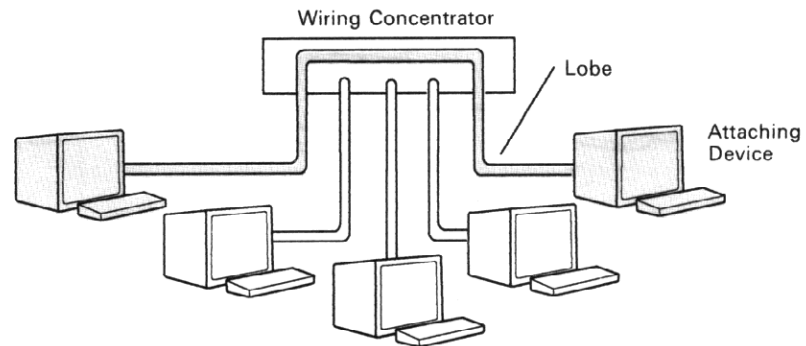
The star-wired ring minimizes the distance around the ring when only a few attaching devices are using it by bypassing offline devices and their *lobes*. Furthermore, since the lobes all go to access units in central locations, adding new attaching devices, moving existing ones to new locations, or bypassing ring segments that need repair do not affect the operation of the rest of the ring.

When the attaching device wants to gain access to the ring to send or receive messages, the adapter tells the access unit that it wants access to the ring. The access unit then makes the lobe part of the ring. The following figure illustrates the change in the wiring path that occurs when an attaching device becomes part of the ring.

wiring closet. A room that contains one or more distribution panels and equipment racks that are used to interconnect cables. Sometimes called a *network wiring closet* to distinguish it from a telephone wiring closet.

IBM Token-Ring Networks installed in buildings that have been wired with the IBM Cabling System are extremely flexible. All work areas in the building can have cables from work areas to *wiring closets* installed, and cables between wiring closets can be put into place. As your establishment's needs change, modifying your network to meet the new needs is simple.

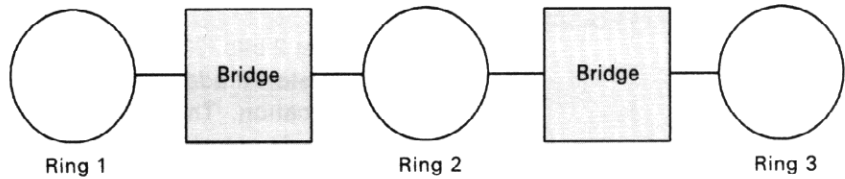
Since all data connectors used with IBM copper cables and in ring components are self-shorting, disconnecting any data connector in the system causes the signal to "wrap around" and travel on the backup path provided in all IBM Cabling System copper cables.



Connecting Rings Together with Bridges

affinity group. A group of network users who routinely exchange information across a network. For example, members of a single department or groups performing similar tasks, such as word processing, both constitute affinity groups.

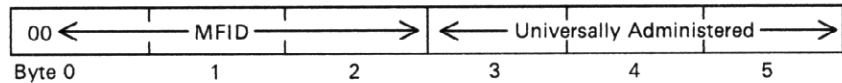
A LAN can consist of one or more rings joined together by bridges. Bridges can be used to connect more than 260 attaching devices together into a single network. By organizing ring members by *affinity groups*, users who have the greatest need to communicate among themselves are assigned to the same ring, yet they can still have access to others who are on rings to which their ring is bridged. The following figure illustrates the topology of a network consisting of three rings connected by bridges. In such a network, all of the members have access to each other by passing frames across the bridges and around the rings until the destination address has been reached.



Addressing

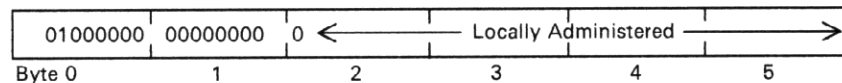
Adapters are able to identify the intended recipient of any frame because each adapter has a unique address. There are two types of addresses: universally administered and locally administered.

All personal computer or Personal System/2 network adapters manufactured by IBM have universally administered addresses encoded on them. These addresses use the following format:



The first 2 bits (00) indicate that the address is a universally administered address. The MFID field contains the manufacturer's identification. The IEEE ensures that every universally administered address is unique.

The user may assign locally administered addresses. A locally administered address overrides the universally administered address encoded on the adapter card. These addresses use the following format:



The first 2 bits (01) identify the address as locally administered. Because of restrictions placed on addresses by certain networking protocols, we recommend that you assign addresses in the range 00000001 – 79999999 (decimal). Your network administrator is responsible for preserving the uniqueness of these addresses.

For additional information about maintaining addresses, see Chapter 2 of this manual and the *IBM Local Area Network Administrator's Guide*.

Performance Considerations

The performance of the IBM Token-Ring Network, like that of many other networks, is a function of the demand placed on the network by the users' traffic. Calculating a network's utilization is a convenient way to quantify demand.

Suppose, for example, that a single-ring network were needed to support 250 attaching devices. If each device generated an average of 4 frames per minute and each frame consisted of 1500 bytes, then the network would be required to transmit 6000 bytes per minute per attaching device. This translates to 48 000 bits per minute per device, or 800 bits per second. With 250 attaching devices, the network's total demand amounts to 200 000 bits per second. For an IBM Token-Ring Network with a capacity of 4 000 000 bits per second, the average utilization for a 250-device network would be 5%. For an IBM Token-Ring Network with a capacity of 16 000 000 bits per second, the average utilization for a 250-device network would be 1.25%.

Performance and utilization are linked: the average time needed to transfer a message across the network (the mean transfer time) increases as network utilization is increased. When represented on a graph, the relationship between transfer time and utilization has a "knee," or bend, in the region of 70–80 % utilization. Transfer times are relatively insensitive to utilizations up to 70%. As utilization exceeds 80%, transfer times increase sharply. Even at these higher utilizations, however, transfer delays are usually small compared with the normally longer application processing times.

The hypothetical 250-device network with its 5% utilization operates well below the bend in the curve of the transfer time relationship. A large reserve would be available for adding traffic-intensive applications such as graphics.

For further information about performance of single-ring networks, see "Estimating Ring Performance" in Chapter 2. For information about multiple-ring networks joined by bridges, see "Connecting to the Establishment Network" in Chapter 4.

Planning Strategies

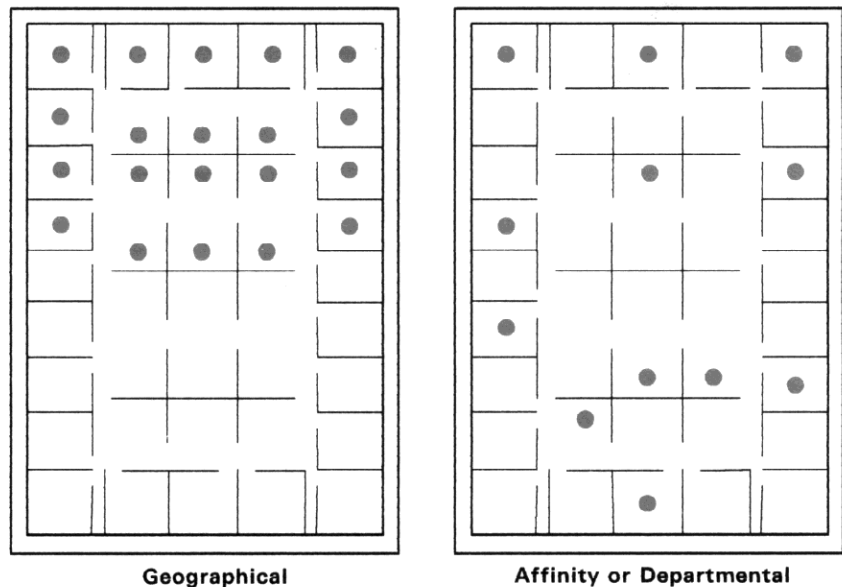
The needs of your establishment and its physical layout will, of course, determine the exact layout of your network. Generally speaking, however, networks are organized either geographically or by affinity groups (the latter are often called *departmental* networks).

Some organizations want a network that is accessible to everyone within a given location for such functions as sharing computer resources and sending messages. Such *geographical* networks are well suited for schools and smaller businesses.

Many networks are better organized by *affinity* groups, that is, groups of users who need to share resources and information. For example, all members of a single department or a series of allied departments may be linked together on a single ring regardless of geographical proximity. Larger organizations will usually find affinity grouping the most effective organization of their resources.

Some networks exist solely to connect other networks together via bridges. These networks are called **backbone networks**. See Chapter 4 for more information about planning backbone networks.

The following figure shows a typical geographical network and a typical affinity network.



IBM Token-Ring Network Components

The following components are currently available for use with your IBM Token-Ring Network.

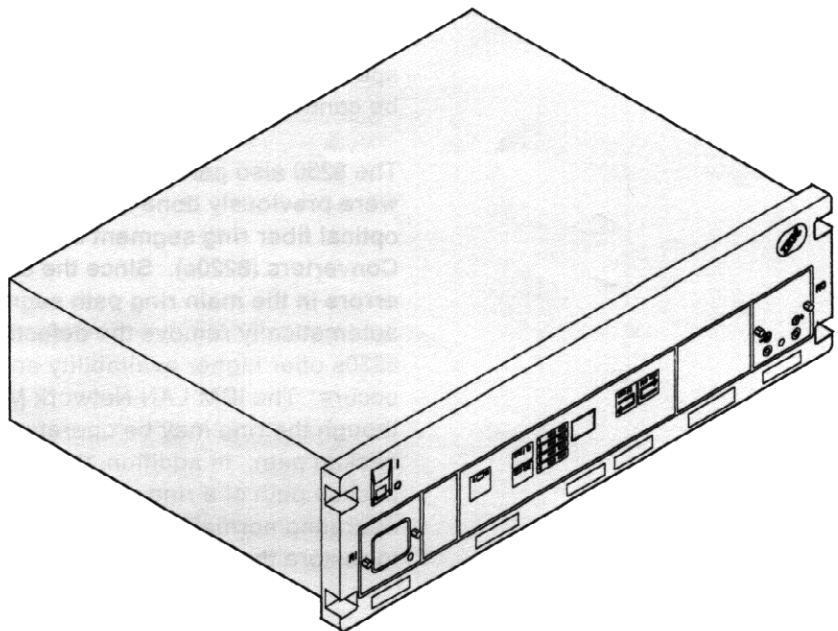
IBM Token-Ring Network Adapters

IBM offers adapters for a wide variety of attaching devices including IBM* Personal System/2* computers, IBM Personal Computers, IBM Industrial Computers, IBM 9370 systems, AS/400* systems, and IBM 3174 Controllers, IBM 3725s, and IBM 3745s. The adapters you choose for your network will depend upon the devices you wish to attach and the data rate (either 4 or 16 Mbps) you have chosen for each single ring.

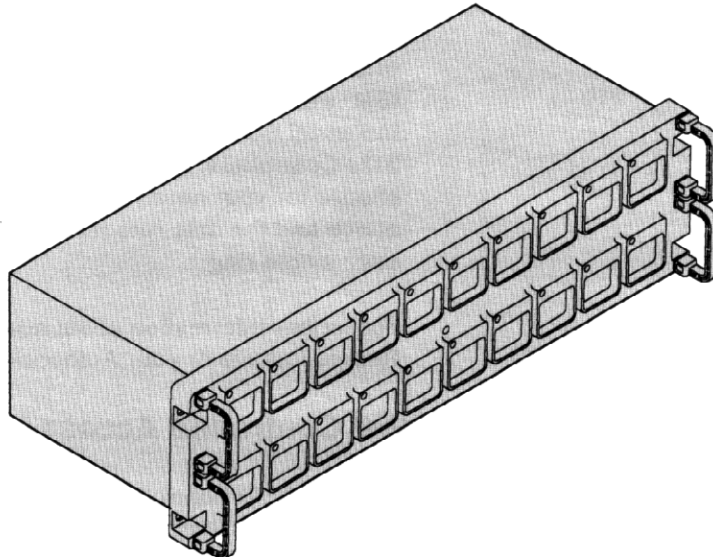
For further information about adapters, consult your IBM Representative or your Authorized Dealer.

IBM Token-Ring Network 8230 Controlled Access Unit

The IBM 8230 Controlled Access Unit (8230) is a wiring concentrator that allows up to 80 attaching devices to have access to a ring. It has been designed for rack-mounted installations in wiring closets. The 8230 consists of a base unit and a Lobe Attachment Module (LAM). The 8230 base unit, when used alone or in conjunction with up to four LAMs, functions as a copper repeater or optical fiber converter at either 4 or 16 Mbps.



Each LAM supports attachment of up to 20 devices. The LAM is available with IBM Cabling System data connectors as the mechanical interface to the lobe cabling or with RJ-45 jacks for use at 4 Mbps on rings operating on telephone twisted-pair (type 3) media. The LAM equipped with IBM Cabling System data connectors may also be used on rings with telephone twisted-pair media lobes.



When used in conjunction with IBM LAN Network Manager and LAN Station Monitor, the 8230 offers significant network management and access control advantages over the IBM 8228 Multistation Access Unit (8228). Using these products together, you can control access to the network so that only those attaching devices whose adapter addresses are registered with the LAN Network Manager for use on a specific 8230 lobe can gain access to the network. Further, lobes can be controlled for availability for only specified periods during the day.

The 8230 also performs automatically error recovery functions that were previously done manually or available automatically only for an optical fiber ring segment bounded by IBM 8220 Optical Fiber Converters (8220s). Since the 8230 base unit has the ability to detect errors in the main ring path segments adjacent to the base unit and automatically remove the defective ring segment, networks that use 8230s offer higher availability and faster recovery when a fault occurs. The IBM LAN Network Manager is notified of the fault even though the ring may be operating satisfactorily by running on its backup path. In addition, the LAN Network Manager can monitor the backup path of a ring containing 8230s even when the ring is operating normally. An appropriate repair action can then take place to restore the ring to its highest reliability.

Note: The configuration reporting functions of the 8230 are not compatible with any of the following devices when such devices are attached to any lobes of the LAM. The devices will cause the 8230 functions to provide invalid or incorrect data to the IBM LAN Network Manager. The devices are:

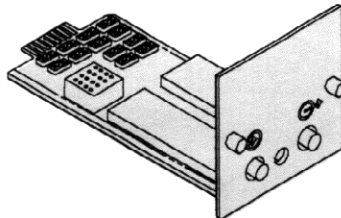
1. Adapters that do not participate in normal token ring protocols, such as the neighbor notification process
2. Fanout devices that attach more than one adapter to a single lobe.

The 8230 has been designed for installation in a 483 mm (19-in.) rack. Its dimensions are 133 mm (5.25 in.) high, 483 mm (19 in.) wide, and 362 mm (14.25 in.) deep with the wrap plug installed. The depth from the mounting surface is 330 mm (13.13 in.). It weighs 7.7 kg (17 lb). The 8230 base unit has an internal fan for cooling and has been designed for installation in a wiring closet environment. The power supply is switchable for either 115 VAC or 220 VAC at either 50 or 60 Hz. The 8230 draws a maximum of 1.8 amps. The 8230 base unit is shipped with an appropriate power line cord for the country in which it will be installed.

The LAM also has been designed for installation in a 483-mm (19-in.) rack. Its dimensions are 133 mm (5.25 in.) high, 483 mm (19 in.) wide, 196 mm (7.7 in.) deep overall, and 142 mm (5.6 in.) deep from the mounting surface. It weighs 4.1 kg (9 lb). The maximum heat dissipation for the 8230 is 85 BTU per hour for the base unit and 39 BTU per hour for each LAM.

IBM 8230 Optical Fiber Converter Module

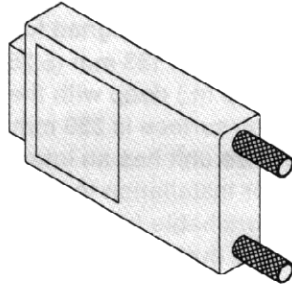
Each 8230 base unit comes equipped with RI (ring in) and RO (ring out) modules designed for use with IBM Cabling System shielded twisted-pair cables. In situations where main ring path cables travel from building to building or where drive distances within a building are greater than the distances supported on copper cable, optical fiber cabling should be used. When optical fiber cabling is required, you should replace the 8230's RI or RO modules with the IBM 8230 Optical Fiber Converter Module, P/N 55F5503.



IBM 8230 4 Mbps Media Filter

When the IBM 8230 is used in networks that employ unshielded twisted pair cables as the lobe wiring, each IBM 8230 base unit must be equipped with an IBM 8230 4 Mbps Media Filter (Media Filter), P/N 53F5551.

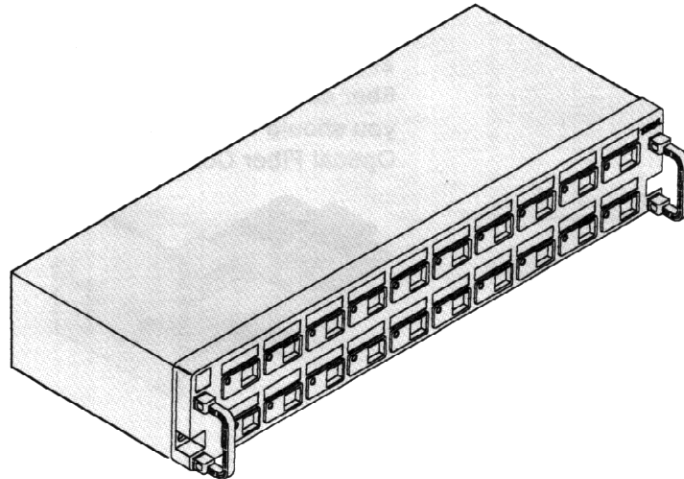
For details about planning 4 Mbps rings using unshielded twisted-pair cables, see the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide*, GA27-3714.



IBM 8230 RJ-45 Lobe Attachment Module

The RJ-45 Lobe Attachment Module (RJ-45 LAM) has been designed to accommodate unshielded twisted-pair lobe wiring by using the industry-standard RJ-45 jack as the mechanical interface to the network. The RJ-45 LAM has the same dimensions as the standard LAM except that its height is 89 mm (3.5 in.). The RJ-45 LAM weighs 3.6 kg (8 lb).

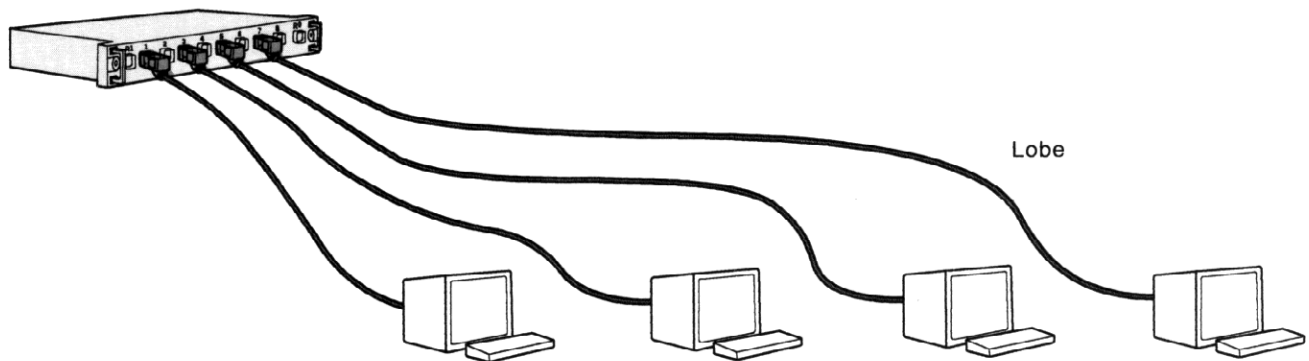
For details about planning 4 Mbps rings using unshielded twisted-pair cables, see the *IBM Token-Ring Network Telephone Twisted-Pair Media Guide*, GA27-3714.



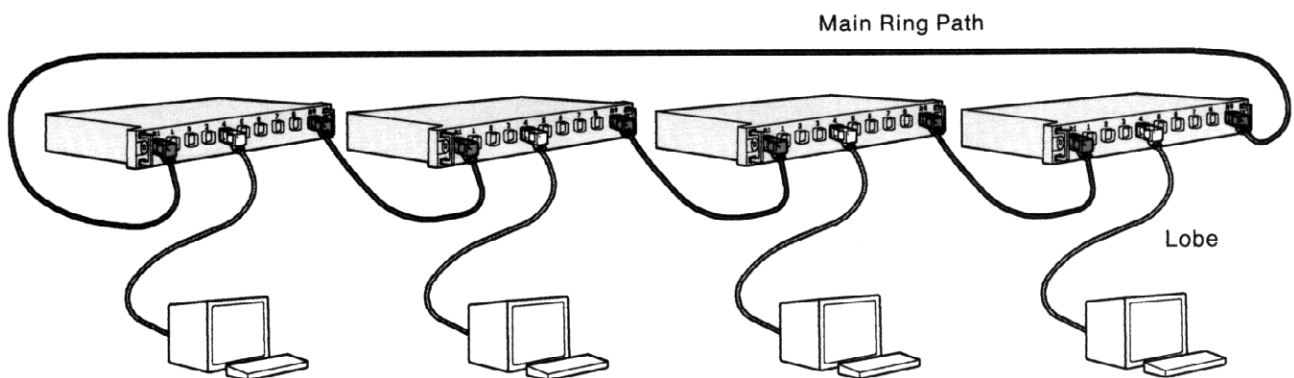
IBM Token-Ring Network 8228 Multistation Access Unit

The IBM 8228 Multistation Access Unit (8228) is an eight-lobe wiring concentrator that can be installed in a rack in a wiring closet or in a component housing that has been wall-mounted or placed on a shelf or table. Each 8228 allows up to eight attaching devices to have access to a ring. The 8228 does not require an external power source for its operation.

The 8228 is 446 mm (17.5 in.) wide, 203 mm (8 in.) deep, and 66.6 mm (2.66 in.) high. It weighs 2.5 kg (5.5 lb). IBM 8228s can be operated in an environment with a temperature range of 10°C – 40.6°C (50°F – 105°F) with relative humidity ranging from 8% – 80%. The wet-bulb temperature should not exceed 26.7°C (80°F). A single 8228 forms a star-wired network as shown below.

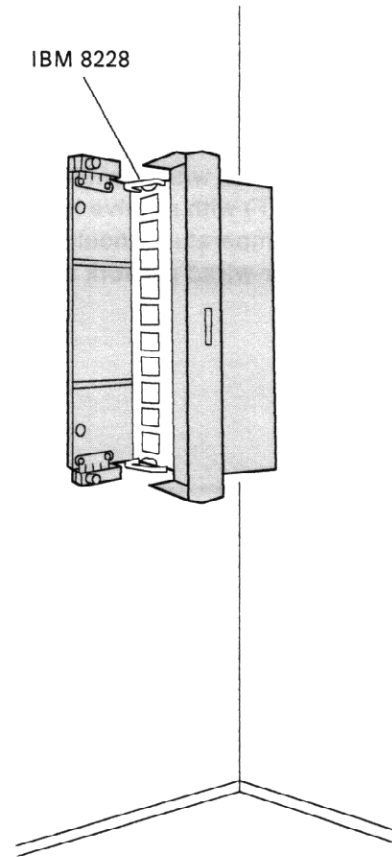


IBM 8228s can be linked together to form rings that are larger than eight lobes by attaching the RO receptacle of one 8228 to the RI receptacle of another 8228, as shown below.



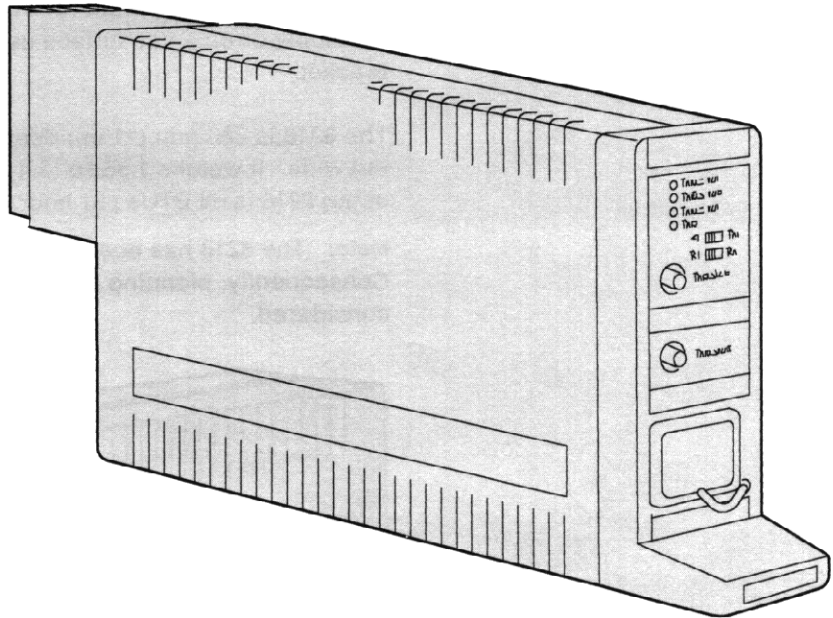
Component Housing

The component housing is used to protect the 8228 when it is installed in a work area or permanently mounted on a shelf or table. The housing also provides cable management brackets and an area for labeling connections.



IBM Token-Ring Network 8220 Optical Fiber Converter

The IBM 8220 Optical Fiber Converter (8220) has a switch-selectable data rate of either 4 or 16 Mbps. Another switch is used to indicate whether the converter is in the RI or RO position in the optical fiber subsystem. An optical fiber subsystem consists of a section of optical fiber cable and patch cables with an 8220 at each end.



Because the 8220 contains all of the major features of the 4 and 16 Mbps adapters, the optical fiber subsystem can be thoroughly tested before it is integrated into the rest of the main ring path at installation. Since the converter senses a loss of signal in the optical fiber path, it can switch to the backup path *without manual intervention*. Further, because each converter has its own universally administered address, it can report status to network management programs. Together these features enhance ring recovery capabilities significantly when compared to the 8219.

The 8220 can be used with 62.5/125-micron optical fiber cable or with other optical fiber cables manufactured by IBM or several other manufacturers. For information about using the 8220 with cables other than the 62.5/125-micron optical fiber cable described in Appendix D, see *IBM Token-Ring Network Optical Fiber Cable Options*.

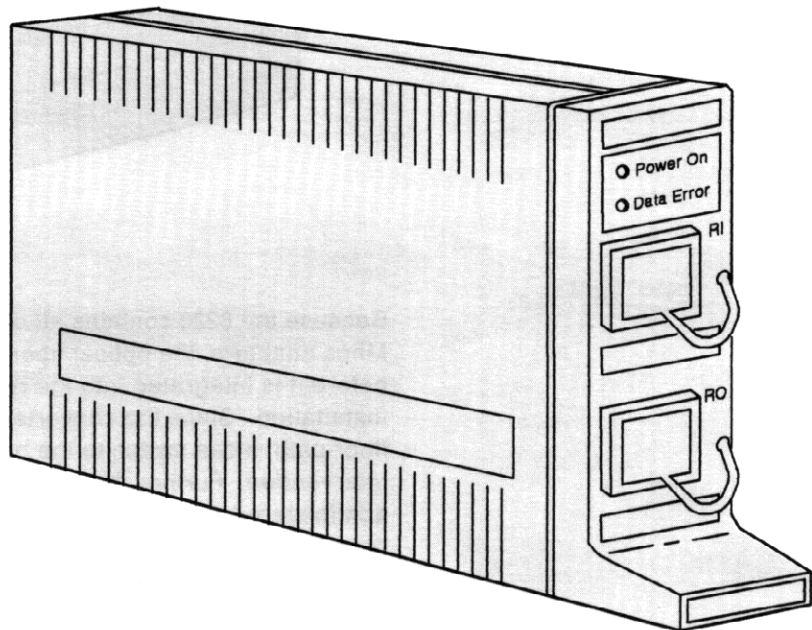
The 8220 is 340 mm (13.3 in.) deep, 152 mm (6 in.) high, and 55 mm (2.2 in.) wide. It weighs 2.27 kg (5 lb). The maximum power dissipation of the 8220 is 116 BTUs per hour.

IBM Token-Ring Network 8218 Copper Repeater

The IBM 8218 Copper Repeater (8218) is a copper wire-to-copper wire repeater that allows a 4 Mbps IBM Token-Ring Network to cover a larger geographic area than a similar network without repeaters. IBM 8218s are installed in pairs on the cables between wiring closets to compensate for signal loss caused by the cables and 8228 Multistation Access Units in the signal path. IBM 8218s can be installed in an equipment rack using an optional rack mounting assembly or on a flat surface using an optional surface mounting bracket.

The 8218 is 280 mm (11 in.) deep, 152 mm (6 in.) high, and 55 mm (2.2 in.) wide. It weighs 1.55 kg (3.4 lb). The maximum power dissipation of the 8218 is 68 BTUs per hour.

Note: The 8218 has been functionally superseded by the 8230. Consequently, planning rings that employ 8218s should be carefully considered.

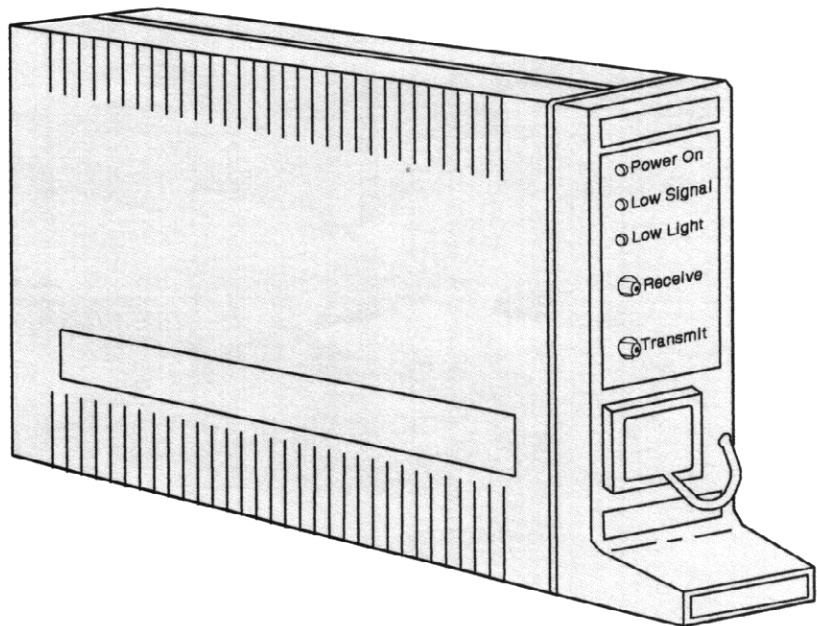


IBM Token-Ring Network 8219 Optical Fiber Repeater

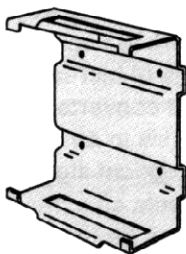
The IBM 8219 Optical Fiber Repeater (8219) allows a 4 Mbps IBM Token-Ring Network to use optical fiber cables between wiring closets as a means of increasing the geographical coverage of the network. The 8219 converts the network signal from an electrical pulse on copper wire to an optical signal on optical fiber cable. It also converts the optical signal back to an electrical pulse when the transmission medium changes from optical fiber cable to copper wire. IBM 8219s can be installed in an equipment rack using an optional rack-mounting assembly or on a flat surface using an optional surface-mounting bracket.

The 8219 can be used with 62.5/125-micron optical fiber cable or with other optical fiber cables manufactured by IBM or several other manufacturers. For information about using the 8219 with cables other than the 62.5/125-micron optical fiber cable described in Appendix D, see *IBM Token-Ring Network Optical Fiber Cable Options*.

The 8219 is 280 mm (11 in.) deep, 152 mm (6 in.) high, and 55 mm (2.2 in.) wide. It weighs 1.55 kg (3.4 lb). The maximum power dissipation of the 8219 is 68 BTUs per hour.

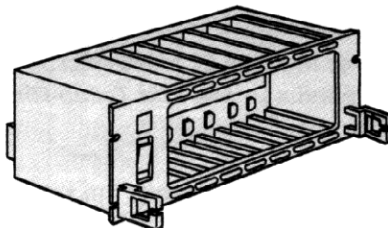


Surface-Mounting Bracket



This bracket is used to install 8218s, 8219s, or 8220s on a wall in cases where the seven-slot rack-mounting assembly is not needed. The bracket comes with a separate optical fiber mounting bracket for use with optical fiber cables when installing an 8219 or 8220.

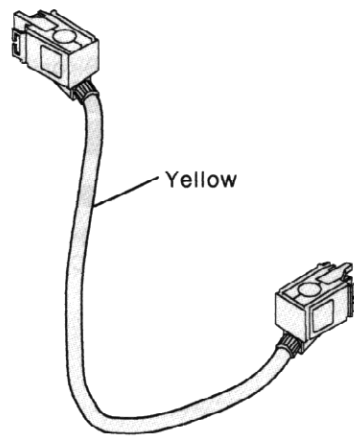
Rack-Mounting Assembly



This assembly is used to install up to seven 8218s, 8219s, or 8220s in any combination in a standard 484-mm (19-in.) equipment rack. The assembly provides electrical power to all of the 8218s, 8219s, or 8220s that are installed in it.

Note: The rack-mounting assembly should be installed at the bottom of the rack above any coaxial patch panels that may be present. No other powered device should occupy the same rack. If you require two rack-mounting assemblies in the same rack, you should leave an unobstructed space of 152 mm (6 in.) between the two rack-mounting assemblies to permit adequate air circulation.

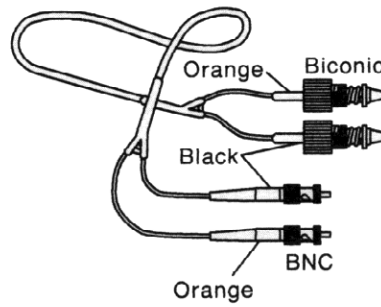
Crossover Patch Cable



The crossover patch cable is a specially designed cable used with two 8218s, 8219s, or 8220s to provide repeating capability for the backup path. Crossover patch cables are **not** required for use with IBM 8230s. The crossover patch cable is 2.4 m (8 ft) long. The cables are yellow to distinguish them from ordinary (black) patch cables. Crossover patch cables cannot be repaired in the field. Chapter 3 of this manual describes use of the crossover patch cables with 8218s, 8219s, and 8220s.

Crossover patch cables (IBM Specification 6339137) are not available from IBM. Contact your IBM representative or local branch office for a list of suppliers of this part.

Optical Fiber BNC-to-Biconic Patch Cables

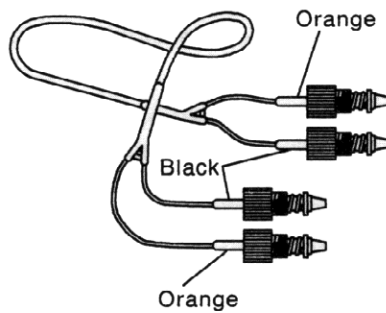


These specially designed patch cables are used to connect the 8219, 8220, or 8230 to any multimode optical fiber cable terminated at a distribution panel or at a strain-relief mounting bracket using biconic connectors. The cable is 2.4 m (8 ft) long. The ends of the cables that attach to the 8219, 8220, or 8230 are color-coded with black and orange heat-shrink tubing to distinguish the two optical fibers in the cable.

Optical fiber BNC-to-biconic patch cables (IBM Specification 6165811) are not available from IBM. Contact your IBM representative or local branch office for a list of suppliers of this part.

For installations that employ ST connectors at the optical fiber distribution panels, IBM also has available an optical fiber BNC-to-ST Patch cable, P/N 83X9120.

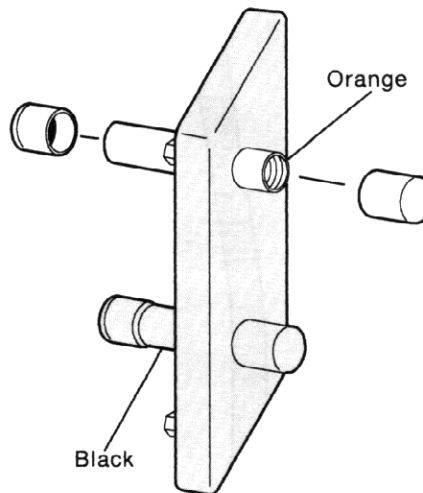
Optical Fiber Biconic-to-Biconic Patch Cables



These patch cables are used to connect any two pieces of multimode optical fiber cables terminated at a distribution panel with biconic connectors. These cables are available in two lengths: 2.4 m (8 ft) and 9 m (30 ft). The connectors are color-coded orange and black to distinguish between the two optical fibers in the cable.

Optical fiber biconic-to-biconic patch cables (IBM Specifications 6165812 and 6165813) are not available from IBM. Contact your IBM representative or local branch office for a list of suppliers of this part.

Optical Fiber Dual Socket Clip



This device is used to adapt the distribution panel connector slots for use with optical fiber cable biconic connectors rather than the standard IBM Cabling System Data Connector. It is also used with the strain-relief mounting bracket supplied with the surface-mounting assembly.

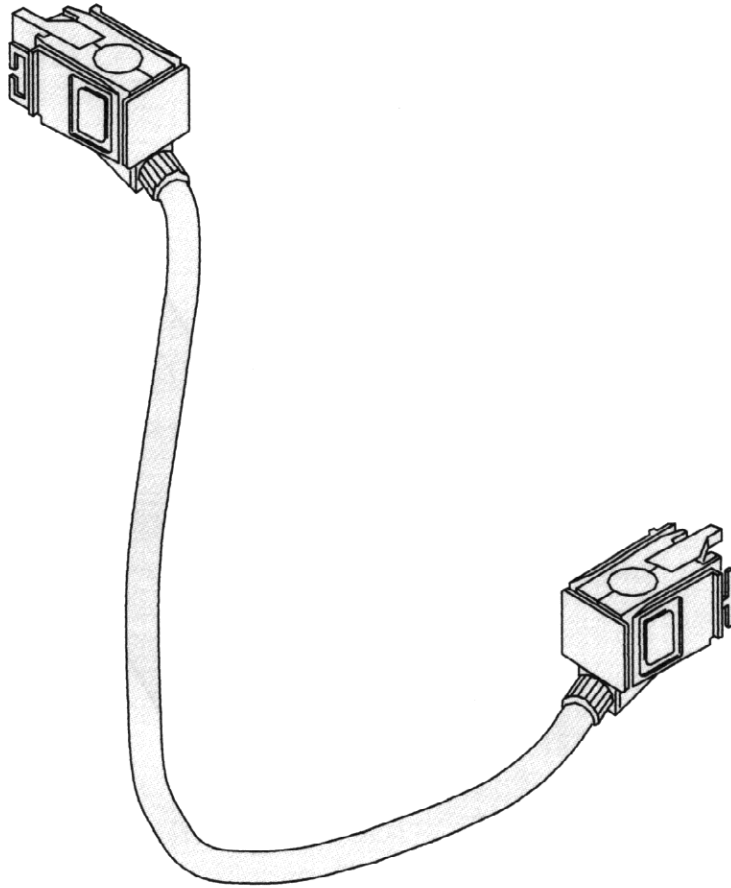
The optical fiber dual socket-mounting clip (IBM Specification 6165847) is not available from IBM. Contact your IBM representative or local branch office for a list of suppliers of this part.

IBM Cabling System Patch Cables

Patch cables connect network products together and to IBM Cabling System components and accessories. Patch cables are used in your network:

- Between distribution panel connectors and 8228 receptacles
- Between 8228s in the same network in a wiring closet
- Between attaching devices and faceplates (optional)
- Between attaching devices and IBM 8228s in component housings (optional)
- Between 8228s and 8218s
- Between 8228s and 8219s
- Between 8228s and 8220s.

Patch cables are available in lengths of 2.4, 9, 23, and 46 m (8, 30, 75, and 150 ft).



Network Management and Diagnostic Tools

In addition to the user diagnostics included with many IBM Token-Ring Network Adapters, IBM offers a comprehensive selection of network management and performance measurement tools designed to provide a wide range of network management options. Your IBM Representative or Authorized Dealer can help you select the network management tools most appropriate for your needs.

Network Software Capabilities

Attaching devices that are part of a network can use any software developed to run under DOS 3.2 (or later) or IBM Operating System/2* (OS/2*), Extended Edition, Version 1.0 (or later). Network operation will not interfere with the normal operation of such software.

You should check the operating system requirements of all applications that you wish to use on the network.

Programs using the NETBIOS interface operate on the IBM Token-Ring Network as well as on the IBM PC Network*.

In addition, programs can be written to the LU 6.2 interface. Such programs allow you to write SNA-type application programs that can operate on the IBM Token-Ring Network.

Any software product that meets the requirements contained in the *IBM Token-Ring Network PC Adapter Technical Reference* should operate on the IBM Token-Ring Network. For further information about programs available for the IBM Token-Ring Network, consult your IBM representative or authorized dealer.

