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Contents

Introduction and Welcome

These are the Proceedings of the IBM Personal Computer Seminar, designed for independent developers of products for IBM Personal Computers. The purpose of these Proceedings is to aid you in your development efforts by providing relevant information about new product announcements and enhancements to existing products. This issue is prepared in conjunction with this seminar. The Proceedings of future seminars for the IBM Personal Computers also will be published and will cover topics presented at those seminars.

Throughout these Proceedings, the term IBM Personal Computer and the term family of IBM Personal Computers address the IBM Personal Computer, the IBM Personal Computer XT, the IBM PC*jr*, the IBM Portable Personal Computer, and the recently announced IBM Personal Computer AT.

Purpose

What is our purpose in issuing a publication such as this? It is quite simple.

The IBM Personal Computer family is a resounding success. We've had a lot of help in achieving this success, and much of it came from the independent developers.

As you proceed with your development, do you at times wish for some bit of information or direction which would make the job easier? Information which IBM can provide? This is the type of information we want to make available to you.

Since we want to be assured of giving you the information you need, we ask you to complete the questionnaire which appears at the end of these Proceedings. Your response to this questionnaire will be taken into account in preparing the content of future issues, as well as the content of seminars we will present at microcomputer industry trade shows.

Topics

The following list gives a general indication of the topics we plan to cover in future seminars and include in the IBM Personal Computer Seminar Proceedings:

- Information exchange forum — letters to the editor format
- Development tools — languages, database offerings
- Compatibility issues
- New devices — capacities and speeds
- System capacities — disk and memory
- Enhancements in maintenance releases
- Tips and techniques
- New system software
- Hardware design parameters
- Tips on organizing and writing documents for clear and easy reading
- Changes to terms and conditions

IBM PC Network Overview

The IBM PC Network is a low-cost, broadband, local area network designed for the IBM Personal Computer family, with exclusions as noted. Its advanced technology provides a highly reliable, low-maintenance network using standard CATV coaxial cable and connection hardware.

The key to providing the network connection is the IBM PC Network Adapter card which plugs into one expansion slot of an IBM Personal Computer, IBM Personal Computer XT, IBM Portable Personal Computer or IBM Personal Computer AT. With the adapter installed in an IBM Personal Computer, a user has the ability to communicate and share resources with any other node on the network. The adapter card contains an Intel 80188 microprocessor, an Intel 82586 Local Area Network (LAN) controller, a single frequency RF modem, two VLSI gate arrays, 40KB ROM and 16KB of Random Access Memory (RAM). These allow the adapter to perform all network functions, including protocol processing through the session layer and free the IBM Personal Computer from having to perform these functions.

In order for the network to be installed and maintained by the user, IBM has designed and preassembled cabling components to erect a passive network. With these cabling components you can attach up to 72 nodes within a 1000-foot radius of the IBM PC Network Translator Unit. The Translator Unit is a low-cost, single-channel device that is required for each network. If a user requires greater capability, the IBM PC Network Adapter may connect to an Other Equipment Manufacturer (OEM) broadband network. In this professionally designed network, you may connect up to 1000 IBM Personal Computers within a 5 Km radius of the OEM translator unit.

In conjunction with the announcement of the IBM PC Network, IBM announced DOS 3.1 and the IBM PC Network Program. DOS 3.1 is an enhancement to DOS 3.0 which has been modified to support networking functions. The IBM PC Network Programs are the DOS-based File, Print and Message Servers. These provide network users with the ability to share disks, printers, data and programs across the network. Any Personal Computer that has a fixed disk may be a file or print server. The servers may run concurrently with another application.

The IBM PC Network consists of:

- Network Adapter

  An intelligent feature card that plugs into the IBM Personal Computer, IBM Personal Computer XT, IBM Portable Personal Computer, or the IBM Personal Computer AT. One adapter is required for each station.

- Network Translator Unit

  A stand-alone unit that provides low-cost, single-function, frequency translation for a network. One translator unit is required for each network.

- Network Cabling Kits

  Preassembled wire and connectors that allow for the installation of a variety of predesigned network topologies.

The network translator and the network cabling hardware provide an IBM PC Network function that is easy to install and maintain. In addition to this offering, the component specifications are documented in the IBM PC Network Technical Reference manual. This will allow customers to take full advantage of the broadband capability of the network adapter using standard broadband components that are readily available from professional CATV and broadband vendors.

IBM PC Network Adapter

The IBM PC Network Adapter is a feature card for connecting the IBM Personal Computer, IBM Personal Computer XT, IBM Portable Personal Computer or IBM Personal Computer AT to the IBM PC Network. The IBM PC Network Adapter is *not* supported on the IBM PC*jr* and the IBM Personal Computer Expansion Unit. Each IBM Personal Computer system unit requires one IBM PC Network Adapter card, which is supplied with a three meter attachment cable. This cable can be connected directly, or with up to 200 feet of additional cable, to the IBM PC Network Translator Unit, or to an IBM PC Network Short, Medium or Long Distance Kit.

Adapter Highlights

- Fixed-frequency assignment for midsplit broadband.
- Highly reliable operation.
- Extensive self-test and diagnostic capabilities.
- On-card auxiliary processor.
- Session layer protocol support.
- Unique network identifier (48 Bits).
- DMA data transfer.
- Station bootstrap across network support.

NETBIOS

The IBM PC Network Adapter contains NETBIOS in ROM which will provide the basis for all program control of the network. These functions and interfaces are layered into five levels of protocol and are derived from contingency work in international standards. The highest layer of support on the IBM PC Network Adapter is commonly called the 'session' layer.

The NETBIOS includes four major groups of functions. These are:

- Session control to create a session and interchange information with another user (name) on the network.
- Datagram functions to send and receive one to one or broadcast datagrams.
- Name control to define multiple users within a node.
- Network adapter status and control.

The above functions can be accessed by interrupt X'5C'

The significance of these high-level interfaces in NETBIOS are:

- They offer an interface for coding network programs conducive to programmer productivity.
- They permit network application programs to be smaller and use less storage.
- They make it possible for multiple operating systems and application programs from any source to use the network with consistent protocol.
- They execute on the adapter card and thus free the system processor for execution of application code.

An important feature of the NETBIOS is the concept of user assignable names. There can be multiple names associated with each adapter card and the names are globally known on the network. This makes it easier to dynamically configure the network under operator or application control. The NETBIOS supports up to 32 concurrent full-duplex sessions on each adapter card.

See the IBM PC Network Technical Reference manual for details of the NETBIOS functions.

PC Network Translator Unit

The IBM PC Network Translator Unit provides broadband frequency translation, from the return channel to the forward channel, for a passive IBM PC Network. The Translator Unit is supplied with a separately packaged transformer which plugs into a standard electrical outlet and powers the unit.

The unit is also supplied with a connector assembly for attaching up to eight IBM Personal Computer stations within a radius of 200 feet (cable segments purchased separately). This assembly also has an expansion port for attaching the IBM PC Network Base Expander Kit, described below in a later section.

Highlights

- Single-channel frequency translation.
- Low-cost network entry.
- Allows up to eight stations to be attached without any other components.
- Supports up to 72 stations within a 1000-foot radius, in conjunction with the IBM PC Network Cable Kits.
- Supports up to 256 stations within a 1000-foot radius with a custom cable installation (not offered by IBM).

PC Network Cable Kits

The IBM PC Network Cable Kits are designed to extend the functional capabilities of the IBM PC Network Translator Unit. These cable kits can be used to increase the maximum number of attached stations from eight to 72 stations, and to increase the maximum distance of coverage from a radius of 200 feet to a radius of 1000 feet. The product offering includes a Base Expander, three Distance Kits and four cable segments, which are preassembled from standard CATV components. All products are designed with industry-standard 'F' connectors for ease of installation. The cable kits described below include all components and cable segments required for end-to-end connection.

The network cabling components are:

- The IBM PC Network Base Expander Kit

  This unit is required to expand the IBM PC Network to more than eight stations or more than 200 feet. It is a prerequisite for the attachment of the Short, Medium, or Long Distance Kits described below. The Base Expander Kit can support up to eight Short, Medium, or Long Distance Kits in any combination.

- The IBM PC Network Short Distance Kit

  The Short Distance Kit attaches directly to the Base Expander Kit and allows up to eight stations to connect to the network within a 200 foot radius of the Short Distance Kit.

- The IBM PC Network Medium Distance Kit

  The Medium Distance Kit attaches, with two 200-foot cables, to the Base Expander Kit. It allows up to eight stations to connect to the network, within a 200 foot radius from this Medium Distance Kit, for up to a maximum of 600 feet from the Network Translator Unit.

- The IBM PC Network Long Distance Kit

  The Long Distance Kit attaches with four 200-foot cables, to the Base Expander Kit. It allows up to eight stations to connect to the network, within a 200 foot radius from the Long Distance Kit, for up to a maximum of 1000 feet from the Network Translator Unit.

The network cabling segments are:

- The IBM PC Network 25 Foot Cable
- The IBM PC Network 50 Foot Cable
- The IBM PC Network 100 Foot Cable
- The IBM PC Network 200 Foot Cable

These cable segments may be used in the following ways:

- To attach a Network Adapter to the Network Translator Unit connector assembly at a distance of up to 200 feet.
- To attach the Medium or Long Distance Kit to the Base Expander Kit at the specified distance.
- To attach a Network Adapter to a network Short, Medium, or Long Distance Kit at a distance of up to 200 feet.

Cable Kit Highlights

- Easily installed.
- Preassembled and pretested.
- Highly reliable and low maintenance components.
- Enter and grow strategy.
- Extensive and highly flexible coverage for various building layouts.

IBM PC Network Hardware

Broadband Overview

The IBM PC Network is a broadband local area network. Broadband networks differ in a number of ways from the more familiar baseband networks. In a baseband network, the data is directly modulated on the cable using all of its bandwidth. In a broadband network, the data is modulated on a carrier frequency which uses only a small portion of the cable bandwidth.

The IBM PC Network uses FM modulation. FM modulation is immune to most noise. Just as lightening has little effect on an FM radio, noise has little effect on the data. Once a carrier is present to the receiver, noise has very little effect since the information is encoded into a frequency, not an amplitude.

A more subtle difference involves the Carrier Sense Multiple Access/Collision Detect (CSMA/CD) protocol and the way that broadband receivers recover the data.

Carrier Sense Multiple Access/Collision Detect

In the CSMA/CD protocol, each IBM PC Network Adapter continuously monitors traffic on the data channel. Anytime there is a pause on the channel, any network adapter can begin transmitting. If only one network adapter begins transmitting during a pause, it gains control of the channel and transmits its message without interruption. If two or more network adapters begin transmitting during the same pause, their signals collide and the garbled data is detected by their receivers (collision detection).

Using a random back-off algorathim, each adapter will attempt a re-transmission at a later time.

Balanced Networks

In baseband networks, the signal delivered to the receiver is inversely proportional to the distance from the transmitter. In order to detect collisions, the receiver must be able to detect a small signal from a distant transmitter in the presence of a large signal from a close transmitter.

In order to detect a collision on a broadband network, the difference in signal strength between any two transmitters must be kept small at the receiver. This requirement led to the development of balanced networks. A balanced network is a network in which the signal strength from any transmitter to any receiver is the same.

Translators

The balanced network design concept is accomplished by breaking it into two parts. A network is designed so that the signal strength from any transmitter to one centrally located receiver is the same. A second network is designed so that the signal strength from a centrally located transmitter to each receiver is the same. The central location is called the headend. The device that moves the data from the centrally located receiver to the centrally located transmitter is called a translator.

Since broadband networks have unused cable bandwidth, the two networks actually can be on the same cable at different frequencies. In this case, and in the case of the IBM PC Network, the translator 'translates' and amplifies the signal received at the centrally located receiver (the adapter's transmit frequency), to the frequency of the centrally located transmitter (the adapter's receiver frequency).

Hardware Description

The IBM PC Network consists of three major components:

- IBM PC Network Adapter
- IBM PC Network Translator Unit
- IBM PC Network Cable Kits

The IBM PC Network Adapter provides the hardware and network protocol for each node. The IBM PC Network Translator Unit provides the translation and amplification required to support the IBM PC Network Adapter and the IBM PC Network Cable Kits.

IBM PC Network Adapter Hardware Description

The IBM PC Network Adapter consists of a single Personal Computer form-factor card. The IBM PC Network Adapter supports the IBM Personal Computer, IBM Personal Computer XT, IBM Portable Personal Computer, and the IBM Personal Computer AT. Because of its form factor, the IBM PC Network Adapter is **not** supported in the IBM PC*jr*. Because of a difference in the DMA structure, the IBM PC Network Adapter is **not** supported in the IBM Expansion Unit.

When the adapters are properly configured, the NETBIOS supports up to two IBM PC Network Adapters in a single Personal Computer. To support this, the IBM PC Network Adapter I/O address space is jumper selectable between 360 hex to 367 hex and 368 hex to 36F hex. The NETBIOS of the second card may be disabled by removing a jumper. Also, the Interrupt level is jumper selectable between Interrupt 2 and Interrupt 3.

The IBM PC Network Adapter uses DMA channel 3. On the IBM Personal Computer and IBM Personal Computer XT, the NETBIOS supports both the fixed disk and the IBM PC Network Adapter on this level. When the DMA is busy, the NETBIOS will initiate transfers under program control until the DMA is free. It will resume DMA transfers when the DMA finishes.

The IBM PC Network Adapter hardware consists of the following major components:

- 6MHz Intel 80188 Processor
- 6MHz Intel 82586 Communication Controller
- 14MHz Sytek Serial Interface Controller
- 32K x 8 Network Protocol ROM
- 16K x 8 Network Protocol RAM
- 32 x 8 Node ID PROM
- PC Interface Controller
- 8K x 8 NETBIOS ROM
- RF Modem

Refer to Figure 1 on page 7 for a block diagram of the IBM PC Network Adapter.

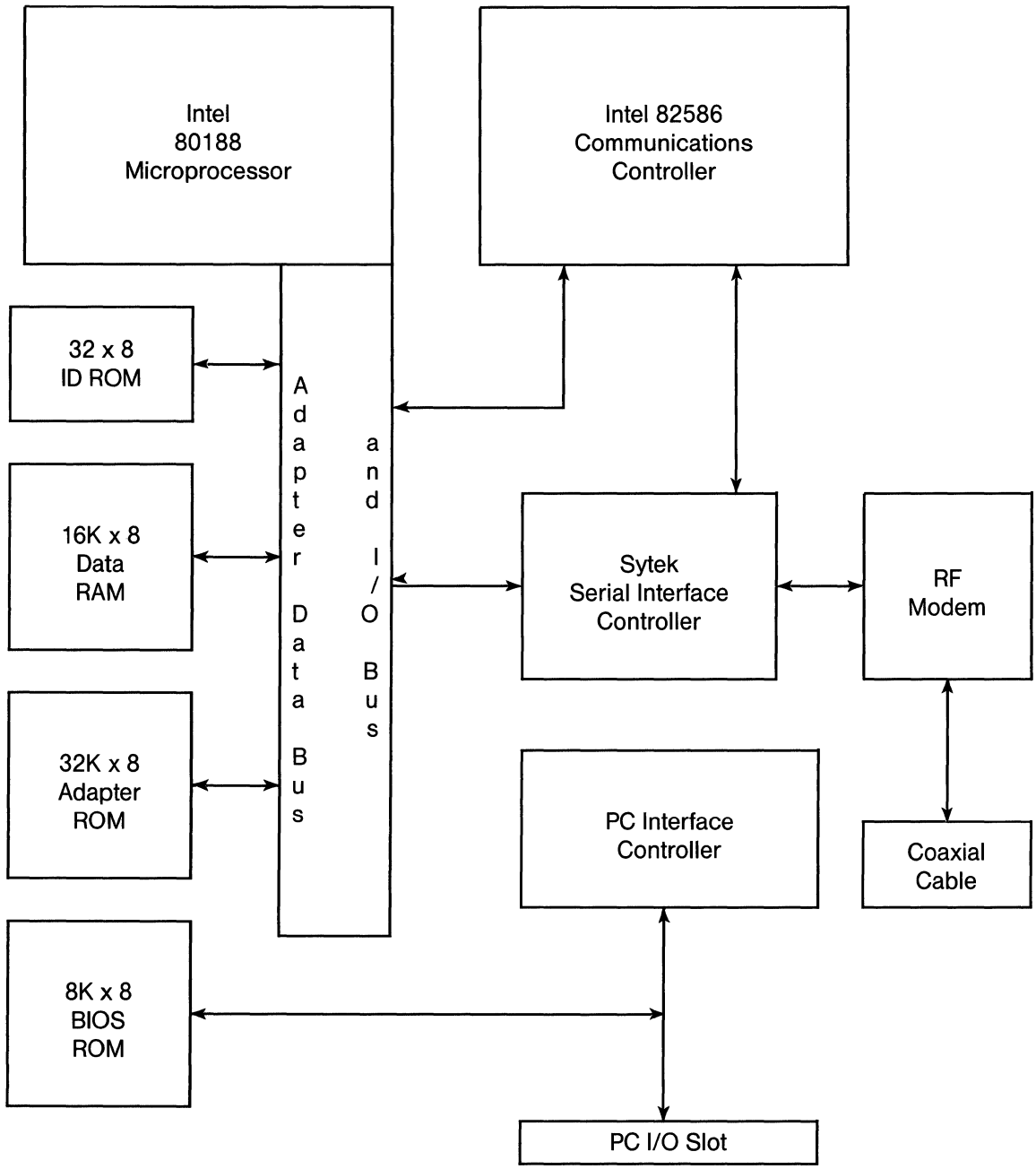


Figure 1. IBM PC Network Adapter Block Diagram

— 6MHz Intel 80188 Processor

The 80188 processor contains DMA channels, programmable timers, interrupt controllers and bus interface logic in a single integrated circuit. It is responsible for executing the higher levels of the network protocols. The 80188 supports three peripherals: the 82586 Communications Controller, the 14MHz Sytek Serial Interface Controller and the PC Interface Controller.

— 6MHz Intel 82586 Communication Controller

The 82586 controller is a co-processor that shares responsibility for the lower levels of the network protocol with the serial interface controller. The 82586 is responsible for fetching data to and from memory, packetizing the data to and from a HDLC format, error recovery and retry, adhering to CSMA/CD protocol, serializing the deserializing data and link-level packet recognition.

— 14MHz Sytek Serial Interface Controller

The serial interface controller interfaces to the 82586 and the RF modem. It is responsible for NRZI encode and decode function, clock recovery, collision-detect monitoring, hot carrier and no carrier detection, and carrier sense control.

— Network Protocol ROM and RAM

The network protocol is implemented in a program that resides in the on-card 32K x 8 ROM. The protocol utilizes 16K x 8 of adapter RAM for data buffers, stack area and program pointers.

— 32 x 8 Node ID PROM

Each IBM PC Network Adapter has a unique unalterable ID that is assigned to it at the time of manufacture. The ID is kept in the 32 x 8 ID PROM. The ID may be read by using the get status secondary command.

— PC Interface Controller

The PC Interface Controller is a custom gate array that interfaces between the PC processor and the IBM PC Network Adapter processor. The controller provides low level primary commands that move data and secondary commands between the PC and the IBM PC Network Adapter processor.

— 8K x 8 IBM PC Network Adapter NETBIOS

The IBM PC Network Adapter NETBIOS acts as an interface between the PC Interface Controller and the application program. The entry points provide the secondary command level of interface and eliminates the need for an application program to use the primary commands.

— RF Modem

The IBM PC Network Adapter RF Modem consists of a 50.75 MHz transmitter and a 219 MHz receiver completely contained within a metal shield. Each channel is 6 MHz wide and of sufficient spectral purity to co-exist with video.

The modem is CATV compatible in signal level and quality. However, it is not compatible in signal level tolerance. Most CATV networks have signal level variations that exceed the range of the IBM PC Network Adapter.

The IBM PC Network Adapter will operate on a properly designed network of up to 5 kilometer radius with up to 1000 IBM PC Network Adapters attached.

IBM PC Network Adapter Diagnostics

The IBM PC Network Adapter diagnostics are broken into three groups: the power-on self tests that are performed only after an IBM PC Network Adapter Reset; the on-line tests that are performed as a result of an error condition; and the diagnostic statistics function that keeps error statistics during normal operation.

Power-on self tests consist of the following:

- ROM And RAM tests
- 80188 CPU tests
- PC interface tests
- Digital loop-back test
- Cable loop-back test

Failure of any test except the PC Interface Test will keep the IBM PC Network Adapter from participating on the network. A PC Interface Test failure will cause the adapter to post an error. The PC, by participating in the PC Interface Test, will detect and post an error message to the application program and disable the PC interface. The IBM PC Network Adapter, however, will be active on the network. This permits another IBM PC Network Adapter to get the failing adapter's status using the get status 'secondary' command.

The on-line tests include hot carrier recognition and missing carrier detection.

— Hot Carrier Recognition

The CSMA/CD protocol requires a pause on the channel before any transmitter can begin transmitting. If a fault condition exists on an IBM PC Network Adapter causing its transmitter to be on continuously, then no IBM PC Network Adapter can ever transmit. This condition is called a 'hot carrier.'

The IBM PC Network Adapter recognizes a 'hot carrier' by the lack of a pause. The IBM PC Network Adapter then ignores the CSMA/CD protocol and transmits a packet to itself through the Hot Carrier. If the packet is garbled, the IBM PC Network Adapter reports a 'hot carrier elsewhere' to the operating system. If the packet is received without error, the IBM PC Network Adapter reports the 'hot carrier here' to the operating system. This allows the operator to remove the offending IBM PC Network Adapter from the network.

— Missing Carrier Detection

If, in the process of transmitting, the IBM PC Network Adapter does not detect a carrier at its receiver, the IBM PC Network Adapter reports an error to the operating system.

— Diagnostic Statistics

The IBM PC Network Adapter keeps the following statistics during normal operation:

- Reporting period
- CRC error count
- Alignment error count
- Collision count
- Transmission and retransmission count
- Reception count
- Self-test result

These statistics may be interrogated locally from the IBM PC Network Adapter or remotely from another IBM PC Network Adapter on the network by using the get status secondary command.

IBM PC Network Translator Unit

The IBM PC Network Translator Unit consists of the translator and the translator connection hardware.

Refer to Figure 2 on page 11 for a block diagram of the IBM PC Network Translator Unit components.

— Translator

The translator supports a single channel (50.75 MHz and 219 MHz), passive data only network of up to 1000 feet with up to 256 IBM PC Network Adapters. The spectral purity and signal quality of the translator does not support cable amplifiers, multiple channels or video. Note, however, that this is not a statement of the IBM PC Network Adapter which does permit active networks with multiple channels and video.

— Translator Connection Hardware

The translator connection hardware is the interface between the translator and the IBM PC Network Cable Kits. Eight IBM PC Network Adapters may directly attach to the translator connection hardware through up to 200 feet of cable. For distances beyond 200 feet or for more than eight IBM PC Network Adapter connections, the translator connection hardware provides an expansion port which is used by the IBM PC Network Cable Kits

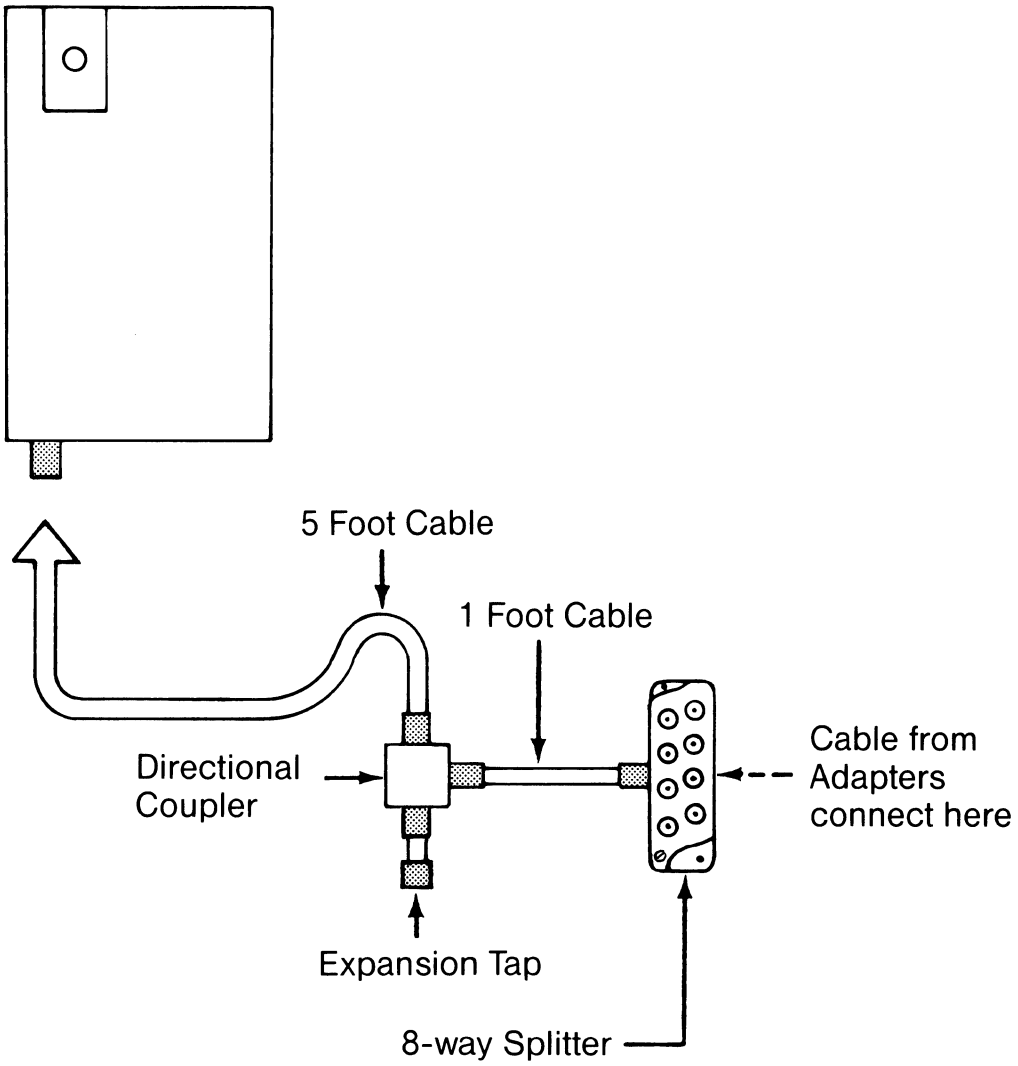


Figure 2. IBM PC Network Translator Unit Components

IBM PC Network Cable Kits

The IBM PC Network Cable Kits consist of the following four kits and four cable segments:

- Base Expander Kit
- Short Distance Kit
- Medium Distance Kit
- Long Distance Kit
- 25 Foot Cable Segment
- 50 Foot Cable Segment
- 100 Foot Cable Segment
- 200 Foot Cable Segment

A fully configured network using the IBM PC Network Cable Kits has a 1000-feet radius range from the IBM PC Network Translator Unit and attaches up to 72 IBM PC Network Adapters. Each kit is designed to cover a specific area requirement. Up to 200 feet of cable may be used between any Short, Medium or Long Distance Kit and an IBM PC Network Adapter.

Refer to Figure 3 on page 13 for a block diagram of the IBM PC Network Cable Components.

— Base Expander Kit

The Base Expander Kit is the interface between the IBM PC Network Translator connection hardware and the rest of the IBM PC Network Cable Kits. It attaches directly to the expansion port of the IBM PC Network Translator connection hardware and provides eight expansion ports for additional cable kits.

— Short Distance Kit

The Short Distance Kit attaches to the Base Expander Kit. It provides eight adapter ports located one foot from the Base Expander Kit.

— Medium Distance Kit

The Medium Distance Kit attaches to the Base Expander Kit. It provides eight adapter ports located 400 feet from the Base Expander Kit.

— Long Distance Kit

The Long Distance Kit attaches to the Base Expander Kit. It provides eight adapter ports located 800 feet from the Base Expander Kit.

— Cable Segments

Cable Segments may be used to extend the distance from an adapter port on the Base Expander Kit and Distance Kits or Translator connection hardware and the IBM PC Network Adapter. The maximum distance from the cable kit adapter port to the IBM PC Network Adapter is 200 feet and should contain a maximum of four cable segments. The cable segments are also used to make up the 400 or 800 feet required respectively between the Base Expander Kit and the Medium or Long Distance Kits.

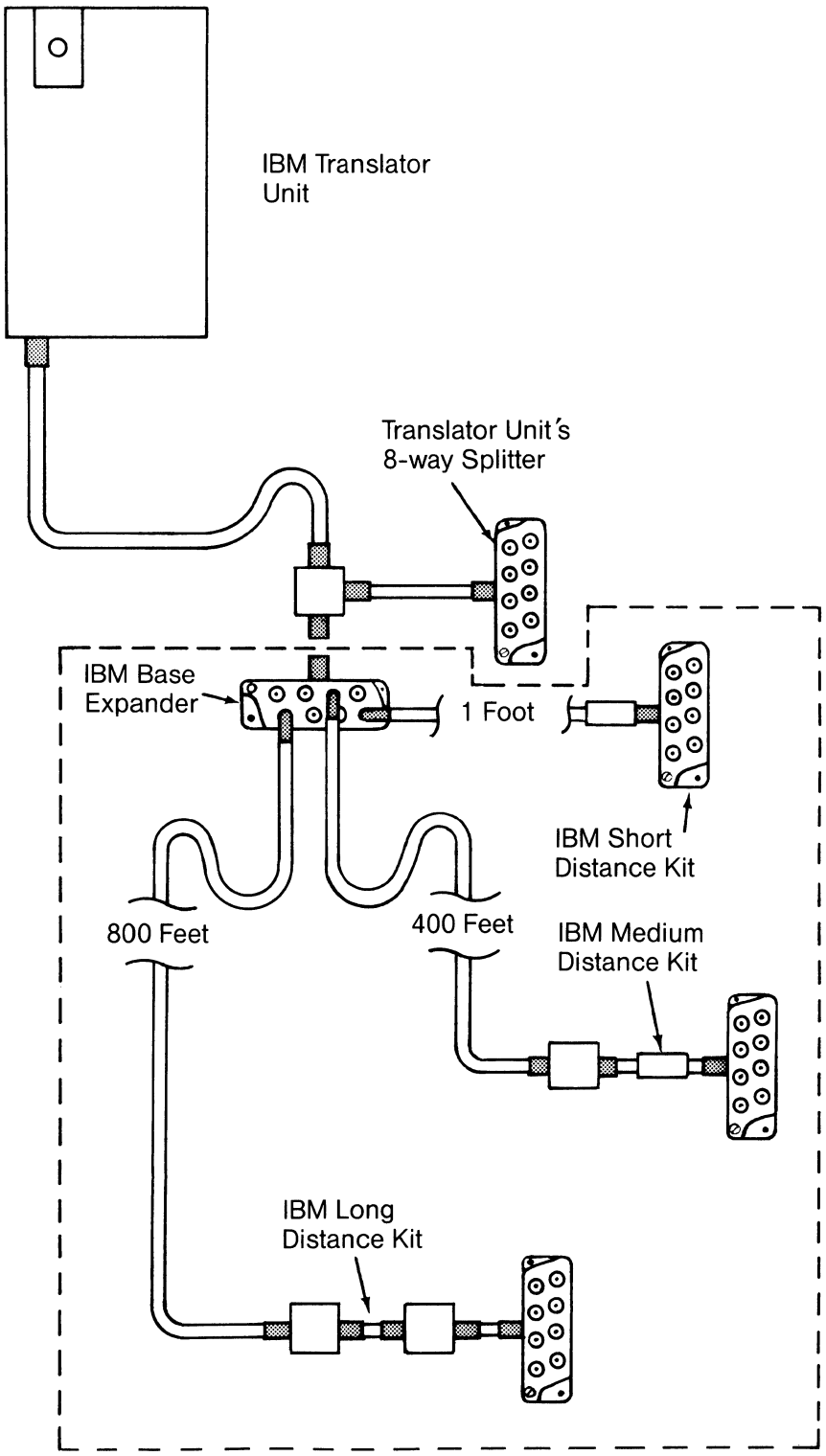


Figure 3. **IBM PC Network Cable Components: Base Expander Kit —Short, Medium and Long Distance Kits**

Network Characteristics

Figure 4 summarizes the characteristics of the IBM PC Network Adapter in various networks.

	IBM PC NETWORK ADAPTER WITH...		
CONFIGURATION / CAPABILITY	IBM CABLE KITS AND IBM TRANSLATOR	CUSTOM NETWORK AND IBM TRANSLATOR	CUSTOM NETWORK AND COMMERCIAL TRANSLATOR
Video Capability	No	No	Yes
Multiple Channels	No	No	Yes
Distance (radius)	1000 Ft.	1000 Ft.	5 Km.
# Nodes	72	256	1000

Figure 4. Network Summary

The component tolerances shown in Figure 5 is a graphical representation of the tolerance of each portion of the IBM PC Network. This includes the IBM PC Network Adapter, the IBM PC Network Translator and the IBM PC Network Cable Kits. Any custom network design should stay within these limits, including effects from temperature, humidity, end of life, etc.

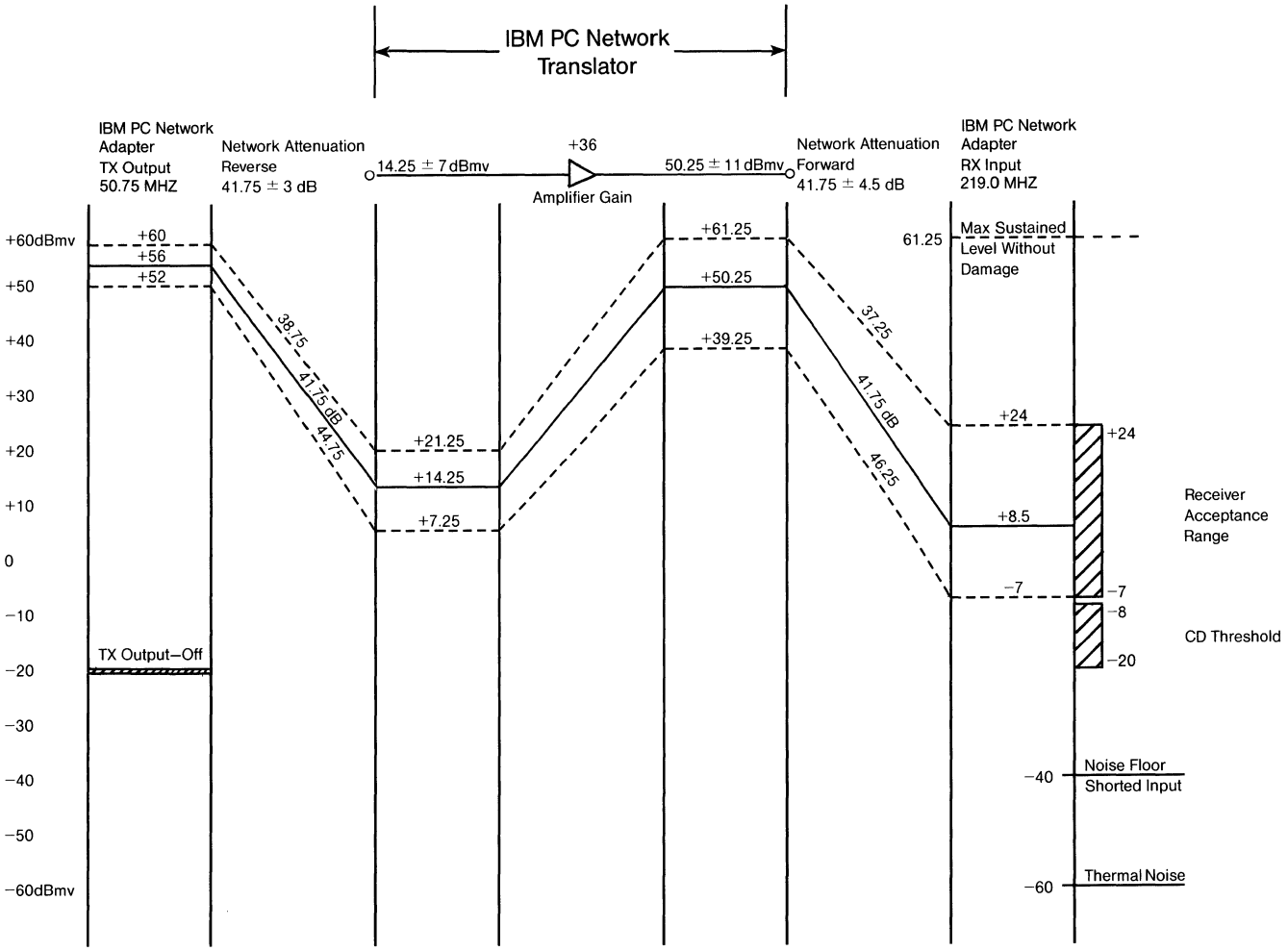


Figure 5. IBM PC Network Component Tolerances

IBM PC Network BIOS (NETBIOS) Architecture

The following section describes the IBM PC Network BIOS (NETBIOS) implemented on the IBM PC Network Adapter. All NETBIOS which runs the network protocol is resident in ROM on the adapter.

Several key objectives influenced the overall design of the network.

- The network should be open to the industry and key interfaces should be published.
- The network should be expandable.
- The network should require no host of any type; a peer-to-peer network is essential.
- Network firmware should conform to industry standards, if possible, and be layered into protocol layers.
- Network function should be executed on the adapter card and off-load the Personal Computer from low-level network interaction.
- All network function below the adapter interface should be implemented in NETBIOS or hardware. This allows remote program load and requires no memory or diskettes in the IBM Personal Computer.
- A session layer adapter interface was the design choice for several reasons. The presentation service layer is operating system dependent and therefore different for various systems. The session layer is also the best layer to introduce the concept of names instead of addresses.

Introduction To Adapter

The IBM PC Network is a broadband local area network designed to logically and physically connect two or more computers. The NETBIOS on the adapter presents a high-level interface to the programmer, thus eliminating the need to know network protocol details. This high-level interface improves system performance by off-loading network programs onto the adapter. Also, this off-loading feature saves memory because the network programs are in the adapter's memory and not in the personal computer's memory. Concepts that are designed within the network are as follows:

- Peer Network

  This means that each member is treated equally and on a first-come, first-served basis. There is no 'host' concept as in telecommunication operations. There are no required centralized facilities of any type on the network other than the hardware translator unit. Peer nodes can be connected with a reliable, point-to-point connection called a virtual circuit.

- Name Service

  When each member is physically connected to the network, a name may be given to represent that member. The names used can be general names, such as 'John', instead of specialized names or numbers.

  If numbers are used, each adapter would have one-fixed address on the network. By making use of names, the IBM Personal Computer program may add up to 16 names for various programs running in the IBM Personal Computer. Each name may have associated sessions or commands which are separate from the other names. An example of the use of names is as follows:

  The IBM PC Network Program may be loaded into the IBM Personal Computer. Once this is done, devices or files may be shared across the network by name. If a file server adds the name SERVER 1, a number of users, (i.e. John, Mary, Bill...) may add their names to their IBM Personal Computer's and access the file server. Once the original IBM Personal Computer is turned off, John, Mary or Bill may move to any other IBM Personal Computer on the network and add their name because there is no dependency on physical addressing and no required centralized directory of names.

Names may also be clustered into logical groups on the network. If a number of users add a group name, then a message sent to that group may be received by all. An example might be that a number of people add a name such as DEPT XYZ. Then, any messages sent to DEPT XYZ may be received by everyone with that name. Names must be used for both Session Services and Datagram Services.

- Session Services

  After the names for each member are specified, two of the members may communicate with each other in a mode called a session. Sessions are similar to a telecommunication-reliable, point-to-point, two-way connection. For the IBM PC Network, a session can also be referred to as a virtual circuit.

- Datagram Service

  The IBM PC Network supports messages called datagrams. Datagram services do not provide a reliable point-to-point connection. The datagrams are only sent once and must be received immediately. The most common type is the broadcast datagram.

The adapter supports all network and protocol functions to assure that messages and data are sent from one computer to another on the network. It also provides the mechanism for returning command status to the IBM Personal Computer following command execution.

Protocol Layers

The IBM PC Network Adapter supports five layers of the data transfer protocols. Each layer comprises one or more protocol services. Each layer communicates only with the layer immediately above or below it. This structure allows a modular design of the protocols. The layers supported by the adapter are as follows:

- Physical layer
- Link layer
- Network layer
- Transport layer
- Session layer

The physical layer is implemented using the RF modem on the adapter and the interface logic to the Intel 82586 Communications Controller.

The link layer is implemented primarily in hardware by using the Intel 82586.

The other three layers (network, transport and session) are implemented using the Intel 80188 processor and ROMs on the adapter. Also, the layers provide a reliable virtual connection service, a name support facility and a low overhead datagram service.

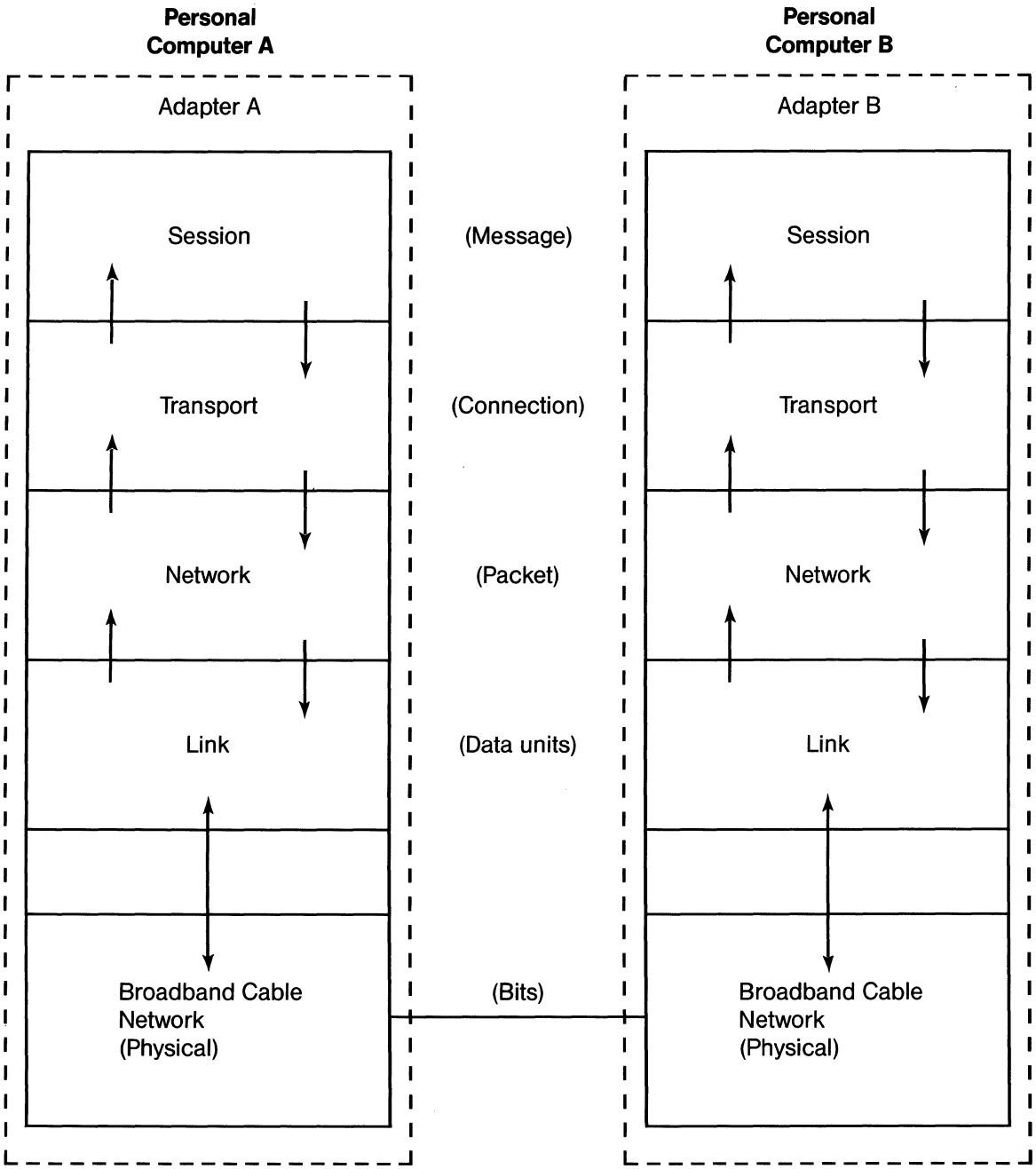


Figure 6. Network Layers

Programming The IBM PC Network Adapter

The following section outlines basic concepts of how to program your adapter using the Network basic input output system (NETBIOS) and its interface to the IBM Personal Computer. Although the network is composed of many layers, the NETBIOS presents one interface to the IBM Personal Computer operating system and should always be used.

IBM PC Network Adapter Characteristics

All of the communication functions from the physical layer through the session layer are handled on the adapter.

The NETBIOS is a software interface between the adapter and IBM Personal Computer programs. The NETBIOS places the unique features of a local area network into a standard format.

Network security is not built into the NETBIOS. Instead, it is the responsibility of the operating system or application program to make sure that data or devices are secure on the network.

Data Transfer

Two basic types of data transfer are supported. Data transfer under session support makes sure that a message is received. If the line to another system drops or is lost, the NETBIOS returns an error code.

Data transfer using datagram support goes directly to the link layer. This type of transfer does not contain such features as found in the session layer.

Name Support

You must communicate on the network by using names. Each adapter can hold up to 16 names and one permanent node name. Each has a length of 16 characters and all 16 characters are always used in a name.

Using The Network

In order to communicate on the network a few simple steps are required.

1. Add your name to the table of names on the adapter. This is the name that you are known by on the network.
2. Establish a session with another name on the network. This gives you a logical connection with another name. The other name can be in your name table or in a name table of another adapter.
3. Send and receive messages using that session.

NCB Commands

Network Control Block (NCB) is used to issue commands to the adapter from the IBM Personal Computer memory. The command block is issued by interrupting the adapter and pointing to the command block. When the command completes, the IBM Personal Computer is interrupted and status is returned. Data transfer from the IBM Personal Computer to the adapter is primarily via DMA.

NCB commands control an adapter on the network. The commands are divided into four categories:

- General
- Name support
- Session support
- Datagram support

Within each category, the commands are further divided into wait and no-wait options. The wait option means that when you issue the command, the processor waits until the command is completed before returning to the next instruction. The no-wait option means that the processor returns immediately after issuing the command and is interrupted at the post address when the command is completed.

Name Support Commands

Name support commands allow your IBM Personal Computer to be known by a name on the network. The commands are add name, add group name, and delete name. A name can be a unique name or a group name on the network. The adapter checks to see if a name is unique on an add name and returns an error if anyone else is using the name you want to add. When using an add group name, the same name can be added by many adapters on the network.

The adapter can have up to 16 names in the local name table. A permanent node name is always present and consists of ten bytes of binary zero

followed by the unique adapter unit ID number. This permanent node name is also unique on the network.

Session Support Commands

Session support commands allow you to establish a logical connection (session) on the network, send and receive messages, end sessions and read session status. More than one command can be outstanding because the connection is in a two-way simultaneous transmission mode.

Sessions are established between any two names on the network. These names can be on your adapter or any other adaper. Names are used to establish sessions, but a one-byte number is used to refer to each session after they are established. A maximum of 32 sessions are allowed. The same name pair can be used to establish more than one session.

Session support gives you reliable data transfer and receipt of a message. Messages can range from 0-65,535 characters in length.

Datagram Support Commands

Datagram support commands allow you to send a message to a name, a group name, or to broadcast a message to everyone. These commands also allow you to receive a datagram message from a name, a group name, or from anyone on the network. Datagram support differs from session support in several ways. The message is never acknowledged by the receiver's adapter, so it is up to the sender and receiver to agree on their own network protocols. Messages can range from 0 to 512 bytes in length.

Datagrams are smaller than session SENDs and require additional protocol interaction for reliable data transmissions. For reliable transmissions, session SENDs should always be used.

Remote Program Load (RPL) Feature

The NETBIOS on the IBM PC Network Adapter provides the capability to load a computer from the IBM PC Network. The IBM PC Network NETBIOS redirects the initial diskette read requests to the network if there are no other drives enabled and the RPL jumper on the adapter is removed. The boot request goes to a special IBM name on the network called IBMNETBOOT. The IBMNETBOOT name must be active, and it must handle the BOOT request from remote IBM Personal Computers. This function does not depend on the operating system and can operate with any system that uses diskette I/O during bootstrap. The main restriction is that the operating system must use Interrupt 13 requests and not try to use the diskette hardware directly.

Performance Considerations

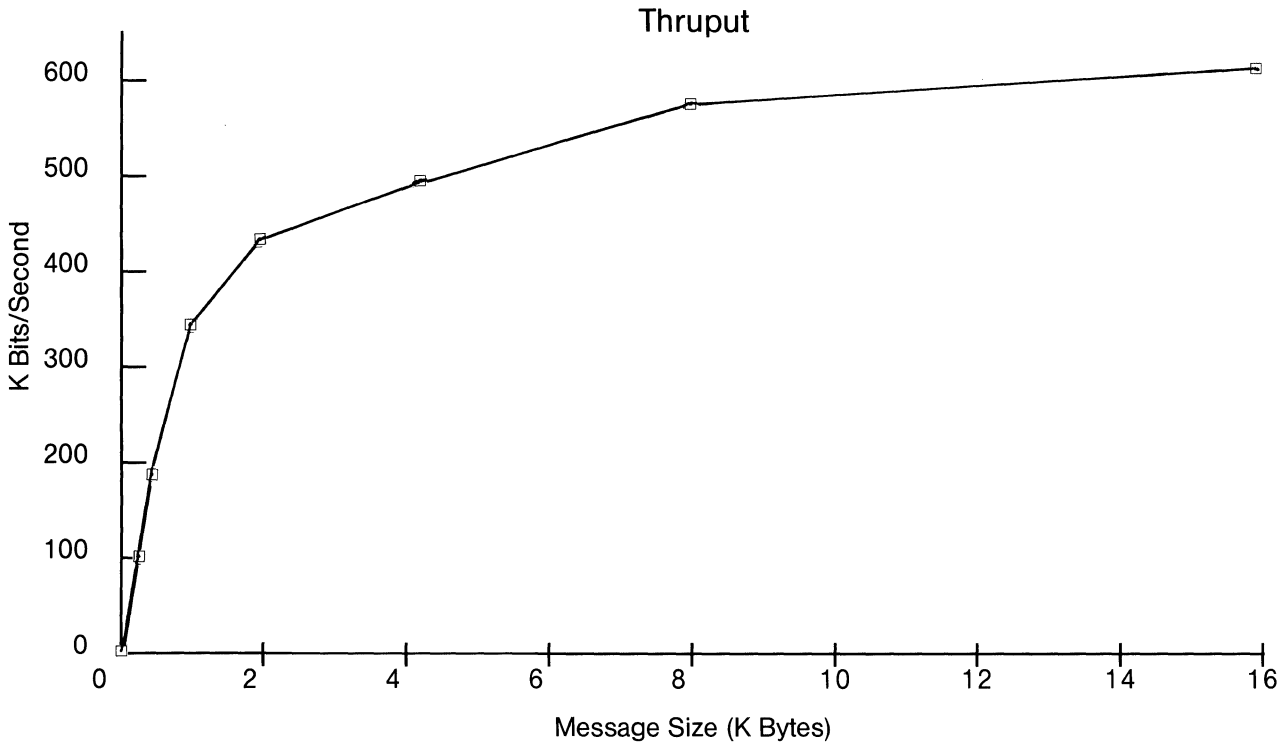
There are a number of steps which may be taken to optimize the performance of each adapter. The major consideration when using the adapter should be to send data in as large a block as possible. This reduces network overhead and maximizes throughput. Data also should be sent using sessions since this allows reliable data transfer and maximum performance. Issuing multiple receive requests is also helpful in some environments since it allows overlap of network activity and local I/O activity on the IBM Personal Computer. In a single point-to-point session, multiple sends of large data blocks on one adapter and multiple receives on the other end will maximize throughput. Using the reset command to configure the adapter to the smallest number of sessions and outstanding commands is also worthwhile since the memory on the adapter is limited. After space is set aside for session entries and command blocks, the remainder is used for buffers. The packet transmitted on the network is equal to or less than the size of the transmission buffer. So, the fewer configured sessions, the larger the packet transmitted on the network.

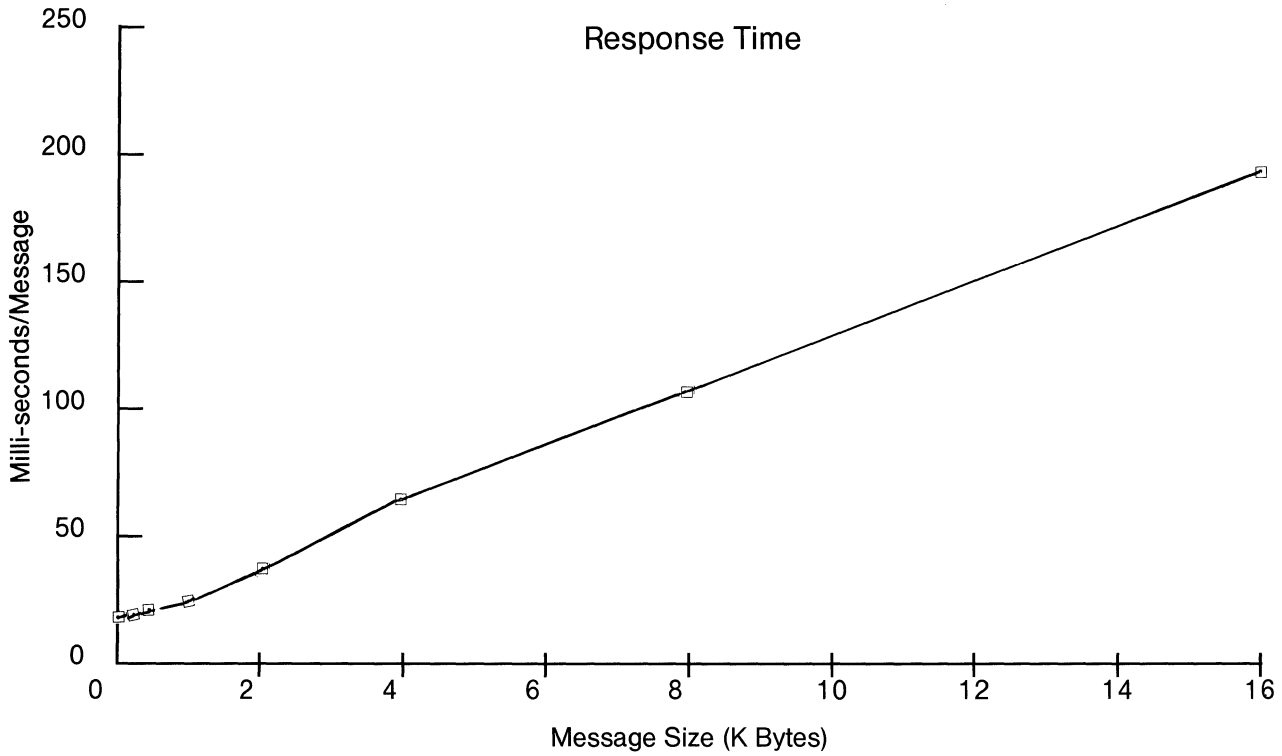
In order to take advantage of the PC Network Adapter features:

- Use session support, **not** datagram support
- Send data in large blocks whenever possible
- Issue multiple commands
- Overlap network requests with other Personal Computer I/O
- Configure the adapter to only the number of sessions and commands you need

The following graphs show the data throughput for a single session transmitting in one direction on an unloaded network. Multiple sends and receives are being used. These are sustained adapter data rates which include the time to go through all layers of the session. The network is capable of sustaining higher aggregate throughput rates where multiple systems are communicating. The first chart shows the data throughput as a function of message size. The second shows the same data as the first in terms of time to send each message.

Adapter Performance Charts





—One way point to point on unloaded net
—Single session, multiple sends and receives

Note:

The IBM PC Network Technical Reference manual contains further information on the meaning of each command. It also contains pseudo code which describes the network action when each command is issued, the NETBIOS assembly listing and the packet formats on the network. The manual includes two sample programs to help you get started using the adapter.

The IBM PC Network Program

The IBM PC Network Program enables IBM Personal Computers to be used in a local area network configuration. The PC Network Program supports the interconnection of IBM Personal Computers, IBM Portable Personal Computers, IBM Personal Computer XT's and IBM Personal Computer AT's, each with an IBM PC Network Adapter. PC*jr*'s are not supported on this local area network.

The IBM PC Network Program allows users to share and use disks, directories and print devices on the network, as well as send, receive and log messages, and do simple file transfer. The PC Network Program provides a range of configurations for users who need different levels of function. It also provides three levels of interface to the network: an easy to learn and use full-screen, menu-oriented interface, a DOS command line interface, and a program interface for application developers.

Figure 7 on page 25 gives a high level overview of the components of the IBM PC Network Program and PC DOS Version 3.1.

Software Highlights

Using the PC Network Program, any IBM Personal Computer XT, IBM Personal Computer AT or IBM Personal Computer with an Expansion Unit can be designated a file/print server, since the file/print server requires a system with a fixed disk. Any disk or directory can be shared with other users on the network. Each instance of a shared disk or directory can have both access rights (read, write, create) and a password specified. Any user on the network can 'use' any disk or directory made available to the network subject to password and access restrictions. The file/print server can provide access to many different disks and directories simultaneously. A new version of PC DOS (3.1) has been developed which specifically includes features to support these functions. Multiple file/print servers can be active simultaneously on the network.

The user's access to a disk or directory appears as if an additional disk drive has been provided on the system. DOS supports the access to the disk drive in a transparent manner, that is, the programs using the disk drive executes as if the drive is attached directly to their IBM Personal Computer. The file/print server machine supports running an application while it is also servicing the network. This allows the server machine to be used as a user machine at the same time other users are accessing its shared resources.

A file/print server can also share up to three IBM compatible print devices on the network. Each print device can be password protected. Print jobs are queued on a file/print server and printed in background mode as the print device they are queued to becomes available. The print queue can contain up to 100 print files concurrently. Functions are available to the operator of the file/print server for examining and modifying the print queue and for controlling the operation of the print devices. Functions are also available to remote users for examining the status of their print files on the server.

File transfer is also supported by a stand-alone, single-session version of the file/print server. Any user wishing to share files can allow another user access to a specific disk, diskette or directory without having to be a full-fledged file/print server. The accessing user establishes communication in the same manner as is necessary to communicate with a file/print server. This version of the file/print server does not allow concurrent operation of an application.

The IBM PC Network Program provides three levels of interface to the network functions: an easy to learn, full-screen, menu-oriented operator interface using function keys, help screens and non-technical vocabulary; a DOS-like command line interface for faster operation and batch file processing; and a program interface with low-level sharing control and network status for application developers. These interfaces ar related to one another as indicated in Figure 8 on page 26.

Message transfer is accomplished in two different modes. One mode is through the full-screen operator interface. This mode allows users to send and receive messages, compose and edit messages via a full-screen message editor, and save and recall received messages for later use. The second mode allows users to receive messages directly to the screen, to a printer, or to be logged to a disk or diskette file. Messages can also be sent via a command from the DOS command line.

Installation And Operation

The IBM PC Network Program manual describes the installation and operation of the PC Network Program. The PC Network Program manual also describes how to install applications on the file/print server machine for use over the network and on the server machine itself.

IBM Personal Computer program license agreements permit the use of a program on a single machine. The customer is responsible for ensuring that each system user on the network is appropriately licensed to use any programs shared over the network.

Prerequisites

Each IBM Personal Computer, IBM Portable Personal Computer, IBM Personal Computer XT and IBM Personal Computer AT on the network requires the following minimum configuration:

- One double-sided diskette drive
- 128KB of memory
- An 80-column display with adapter
- An IBM PC Network Adapter
- DOS 3.1

Each IBM Personal Computer with an expansion unit, IBM Personal Computer XT and IBM Personal Computer AT that is to be used as a file/print server on the network requires the following minimum configuration:

- One fixed-disk drive
- One double-sided diskette drive
- 256KB of memory
- An 80-column display with adapter
- An IBM PC Network Adapter
- DOS 3.1
- An IBM compatible print device (required for print server functions)

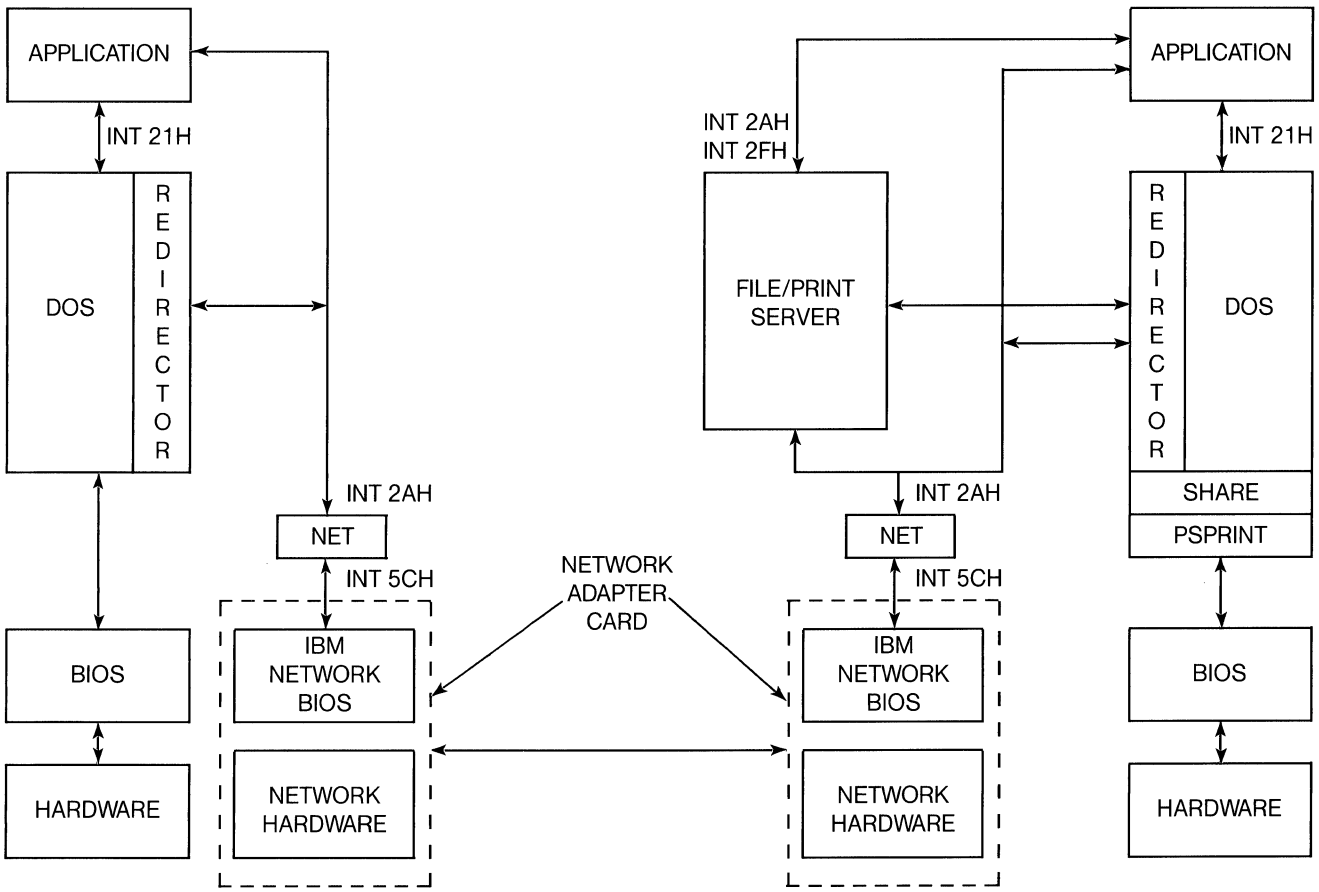


Figure 7. Network Overview

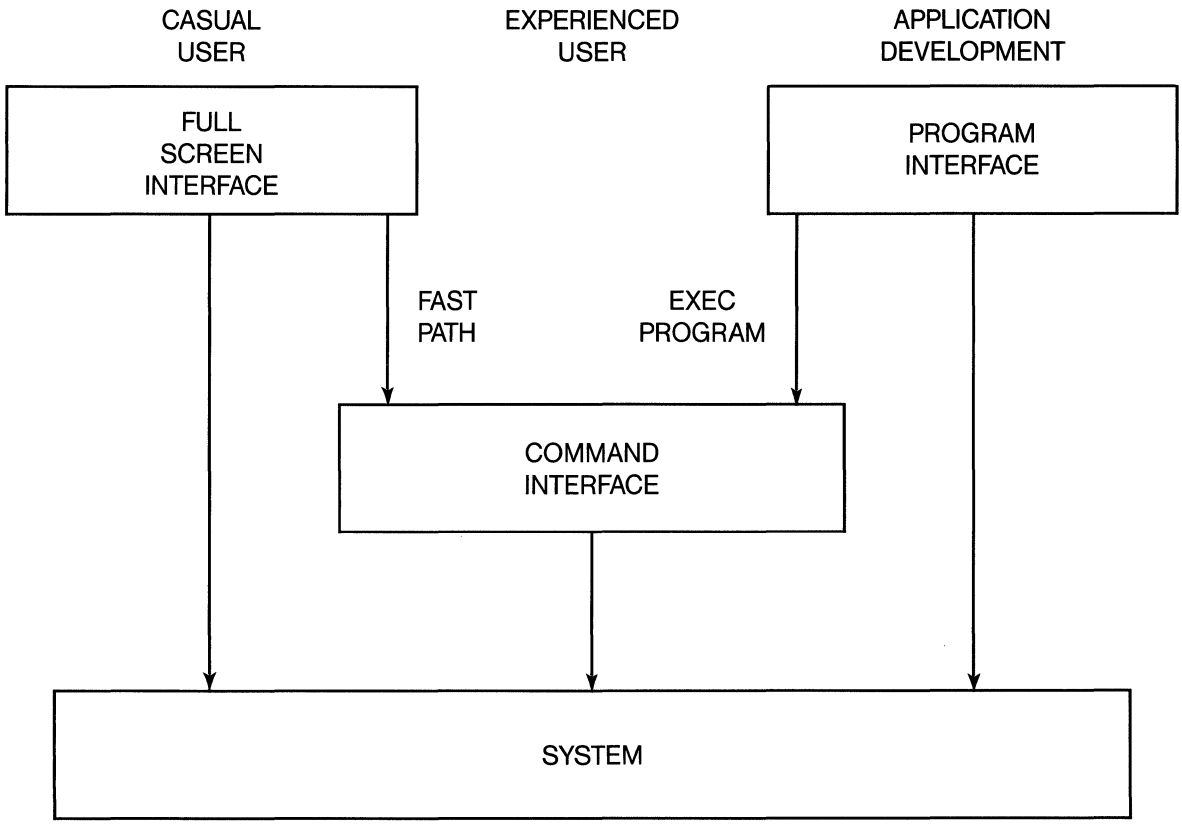


Figure 8. Network Interfaces

Network Program Configurations

The IBM PC Network Program can be configured in four different ways depending on user requirements and hardware prerequisites.

- Redirector — Allows the user to redirect local file I/O (interrupt 21H) and print I/O requests (interrupt 17H) over the network to a file/print server. This makes file/print server resources appear as if they are attached directly to the Redirector machine. Network commands can be issued from the DOS command line. The full-screen interface can be run like an application.

- Receiver — In addition to the Redirector function above, it receives network messages and allows the user to route them to the console, a printer or a file concurrent with the operation of an application.

- Messenger — In addition to the Redirector and Receiver function above, it provides a full-screen editor for messages and the ability to add additional names for the reception of messages and the ability to forward those names to another computer. The user of a Messenger machine can switch back and forth between an application and the full-screen interface.

- Server — In addition to the function of the three configurations above, it supports the sharing of disks, diskettes, directories and print devices concurrent to the operation of an application on the Server machine.

The minimum storage requirement for the Redirector and Receiver configurations is 128KB. The minimum storage requirement for the Messenger and Server configurations is 256KB.

Command Interface

The following functions are provided by the command interface:

Command	Function
NET START	Start up one of the four Network Program configurations
NET SHARE / NET USE	Share and use network resources
NET PAUSE / NET CONTINUE	Suspend and resume network operations on a machine
NET SEND	Send a message(s)
NET LOG	Log message(s) to display, printer or a file
NET NAME	Add a name to a machine for receiving message(s)
NET FORWARD	Forward a name to another machine so that message(s) can be received there
NET PRINT	Print a file on a network printer or get status of print queue
NET SEPARATOR	Define a separator page to be printed between print files on a print server
NET ERROR	List the network error log
NET FILE	List the current users and current record locks for a file
MODE	Set the character and line spacing of a network printer
PERMIT	Stand-alone single-session version of the file server

Program Interface

The program interface to the IBM PC Network Program consists of a set of interrupt calls that provide installation information and redirection control and status for application programs. The following figure lists the functions by interrupt and function code(s).

INT 2FH

AH	AL	
BB	00	NET COMMAND INSTALLATION CHECK
	03	GET SERVER POST ADDRESS
	04	SET SERVER POST ADDRESS

INT 21H

AH	AL		
3D	OPEN FILE WITH SHARING SPECIFIED		
44	09	IOCTL	IS DEVICE REDIRECTED?
	0A		IS HANDLE LOCAL OR REMOTE?
	0B		CHANGE SHARING RETRY COUNT
59	GET EXTENDED ERROR		
5A	CREATE TEMP FILE WITH UNIQUE NAME		
5B	CREATE NEW FILE		
5C	00	LOCK BYTE RANGE	
	01	UNLOCK BYTE RANGE	
5E	00	GET MACHINE NAME	
	02	SETUP PRINTER CONTROL STRING	
5F	02	GET ASSIGN LIST ENTRY	
	03	REDIRECT DEVICE TO NET	
	04	CANCEL REDIRECTION	

INT 2AH

AH	
00	INSTALLATION CHECK
01	EXEC NETBIOS REQUEST
02	SET NET PRINTER MODE
03	GET DEVICE SHARED STATUS

Figure 9. Program Interface

Server/Redirector Protocol

File/print servers and user machines communicate control information and data between each other across the network using the Server/Redirector Protocol. The primary control block in the protocol is the Server Message Block (SMB):

```
SMB             STRUC
                DB          0FFh,'SMB'  ; SMB BLOCK IDENTIFIER TAG
SMB FUNCTION    DB          0           ; FUNCTION CODE
SMB RETCLASS    DB          0           ; RETURN ERROR CLASS
                                        ; VALUES 00-7FH AND 0FFH RESERVED

SMB RETCODE     DW          0           ; RETURN ERROR CODE
SMB HEINFO      DB          0           ; AH VALUE ON INT 24H,
                                        ; ELSE RESERVED
SMB RESV1       DB          0           ; RESERVED, MUST BE ZERO
SMB RESV2       DW          0           ; RESERVED, MUST BE ZERO
SMB RESV3       DW          0           ; RESERVED, MUST BE ZERO
SMB RESV4       DW          0           ; RESERVED, MUST BE ZERO
SMB RESV5       DW          0           ; RESERVED, MUST BE ZERO
SMB RESV6       DW          0           ; RESERVED, MUST BE ZERO
SMB RESV7       DW          0           ; RESERVED, MUST BE ZERO

SMB RESV8       DW          0           ; RESERVED, MUST BE ZERO
SMB NPID        DW          0           ; NETWORK PATH ID
SMB PID         DW          0           ; PROCESS ID
SMB RESV9       DW          0           ; RESERVED, MUST BE ZERO
SMB RESV10      DW          0           ; RESERVED, MUST BE ZERO
SMB PARMCNT     DB          0           ; COUNT OF PARMS
SMB P1          DW          0           ; FUNCTION
                •                       ;   DEPENDENT
                •                       ;     WORD

                •                       ;       PARAMETERS
SMB Pn          DW          0           ; (0 OR MORE)
SMB BUFLEN      DW          0           ; LENGTH OF BUFFER FOR DATA
SMB BUF         EQU THIS BYTE           ; BUFFER AREA
                SMB ENDS
```

Note—All word values are stored in (low, high) order.

```
SMB DATA        STRUC                   ; ID OF ITEM
SMB ID          DB 0                    ; (VALUES 00H to 7FH RESERVED)
SMBSDB          EQU 1                   ; ITEM IS A SERVER DATA BLOCK
SMBDIALECT      EQU 2                   ; ITEM IS A DIALECT ID STRING
                                        ; (PROTOCOL IDENTIFIER)
SMBPATH         EQU 3                   ; ITEM IS AN ASCIZ PATH NAME

                                        ; (RESERVED FOR FUTURE)
SMBASCIZ        EQU 4                   ; ITEM IS AN ASCIZ STRING
SMBVARLEN       EQU 5                   ; ITEM IS FUNCTION SPECIFIC
                                        ;  FORMAT: LIKE SDB
SMB DATUM       EQU THIS BYTE           ; BUFFER AREA
                SMB DATA ENDS
```

For types SMBDIALECT, SMBPATH, SMBASCIZ the format is:

```
                DB          type        ; TYPE ID
                DB          'string'    ; ACTUAL DATA
                DB          0           ; END MARKER
```

For type SMBSDB (Server Data Block) the format is:

```
SDB             STRUC
SDB ID          DB          SMBSDB      ; ID BYTE
SDB BUFLEN      DW          0           ; LENGTH OF BUFFER AREA
SDB BUF         EQU THIS BYTE           ; BUFFER AREA
SDB             ENDS
```

File Sharing

DOS 3.1 provides an extensive range of sharing modes for networking applications, including a compatibility mode for applications written without networking in mind.

Compatibility Mode

A file is considered to be in compatibility mode if the file is opened by:

- Any of the CREATE function calls.
- An FCB function call.
- A handle function call with compatibility mode specified.

A file can be opened any number of times in compatibility mode, provided that the file is not currently open under one of the other four sharing modes. If the file is marked 'read-only',and is currently in Deny Write sharing mode with Read Access, the file may be opened in Compatibility Mode with Read Access. If the file was successfully opened in one of the other sharing modes and an attempt is made to open the file again in Compatibility Mode, an interrupt 24H is generated to signal this error. The base interrupt 24H error will indicate **Drive Not Ready**, and the extended error will indicate that there was a **Sharing violation**.

The sharing modes for a file opened in compatibility mode will be changed by DOS depending on the read-only attribute of the file. This is to allow sharing of read-only files.

Read-Only

File Opened By	Access	Sharing Mode
FCB	Read Write	Deny Write
Handle Read	Read Only	Deny Write
Handle Write	Error	-
Handle Read/Write	Error	-

Not Read-Only

File Opened By	Access	Sharing Mode
FCB	Read/Write	Compatibility
Handle Read	Read/Write	Compatibility
Handle Write	Write	Compatibility
Handle Read/Write	Write	Compatibility

Deny Read/Write Mode (Exclusive)

If a file is successfully opened in Deny Read/Write mode, access to the file is exclusive. A file currently open in this mode cannot be opened again in any sharing mode by any process (including the current process) until the file is closed.

Deny Write Mode

A file successfully opened in Deny Write mode prevents any other write access opens to the file until the file is closed. An attempt to open a file in Deny Write mode is unsuccessful if the file is currently open with a write access.

Deny Read Mode

A file successfully opened in Deny Read mode prevents any read access opens to the file until the file is closed. An attempt to open a file in Deny Read mode is unsuccessful if the file is currently open in Compatibility mode or with a read access.

Deny None Mode

A file successfully opened in Deny None mode places no restrictions on the read/write accessibility of the file. An attempt to open a file in Deny None mode is unsuccessful if the file is currently open in Compatibility mode.

The following sharing matrix shows the results of opening, and subsequently attempting to reopen the same file using all combinations of access and sharing modes.

Sharing Matrix

2ND, 3RD, ... OPEN

1ST OPEN		DRW			DW			DR			ALL		
		I	IO	O	I	IO	O	I	IO	O	I	IO	O
DRW	I	N	N	N	N	N	N	N	N	N	N	N	N
	IO	N	N	N	N	N	N	N	N	N	N	N	N
	O	N	N	N	N	N	N	N	N	N	N	N	N
DW	I	N	N	N	Y	N	N	N	N	N	Y	N	N
	IO	N	N	N	N	N	N	N	N	N	Y	N	N
	O	N	N	N	N	N	N	Y	N	N	Y	N	N
DR	I	N	N	N	N	N	Y	N	N	N	N	N	Y
	IO	N	N	N	N	N	N	N	N	N	N	N	Y
	O	N	N	N	N	N	N	N	N	Y	N	N	Y
ALL	I	N	N	N	Y	Y	Y	N	N	N	Y	Y	Y
	IO	N	N	N	N	N	N	N	N	N	Y	Y	Y
	O	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y

Y : 2nd, 3rd, ... open is allowed
N : 2nd, 3rd, ... open is denied
DRW : Deny Read/Write (Exclusive)
DW : Deny Write
DR : Deny Read
ALL : Allow Read and Write
I : Input only
O : Output only
I/O : Input/Output

IBM Corporation
Editor, IBM Personal Computer Seminar Proceedings
4629
Post Office Box 1328
Boca Raton FL 33432