



PC Server 320

**User's Reference**

## Note

Before using this information and the product it supports, be sure to read the general information under Appendix A, "Product Warranties and Notices" on page 109.

## Second Edition (January 1996)

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# About This Book

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This *User's Reference* is an overview of the technologies and features that make up your server. It is intended for anyone who has an interest in learning more about the IBM PC Server 320.

This reference does not provide specific instructions for performing procedures. That information is in your *PC Server 320 Setup Sheet* and your *PC Server 320 User's Handbook*.

## How This Book is Organized

Chapter 1, "Introducing Your IBM PC Server 320," provides an overview of the features and expansion capabilities of your server. This chapter also includes the PC Server 320 specifications.

Chapter 2, "Understanding Server Performance," contains information about server performance, the advantages of using a local area network (LAN), and tuning your server for optimal performance in your environment.

Chapter 3, "Microprocessors and Memory," contains general information about the microprocessors and types of memory in the PC Server 320 models.

Chapter 4, "Bus Architecture," contains information about the PC Server 320 multiple bus architecture, which provides PCI/Micro Channel or PCI/EISA buses for high performance and a variety of expansion options. This chapter provides a general description of each bus, including information about direct memory access (DMA), arbitration, burst data transfers, and the streaming-data procedure used in some PC Server 320 models.

Chapter 5, "Data Storage Devices," explains PC Server 320 data storage capabilities and includes information about the storage devices that you can install, such as diskette drives, hard disk drives, CD-ROM drives, and tape drives.

Chapter 6, "SCSI Subsystem," describes the SCSI (small computer system interface) subsystem.

Chapter 7, “Disk-Array Subsystem,” contains information about the disk-array subsystem shipped in some PC Server 320 models. It describes the different redundant array of independent disks (RAID) levels as well as the advantages of each.

Chapter 8, “Configuration,” provides information about the configuration process. It also contains a description of all of the configuration programs provided with your PC Server 320.

Chapter 9, “Input/Output Ports,” provides basic information about the serial, parallel, keyboard, mouse, video, and SCSI-2 input/output (I/O) connectors on the PC Server 320 models. Pin assignments for each I/O connector are provided to help you determine whether a device is compatible with your server.

Chapter 10, “Video Subsystem,” contains information about the super video graphics array (SVGA) controller and video device drivers. This chapter also includes detailed information about some of the monitors that you can attach to your server.

Chapter 11, “Security Features,” describes how to secure the server hardware and network data stored on the server, and the selectable-drive startup feature.

Appendix A, “Product Warranties and Notices,” contains your product warranty and special notices, such as a list of trademarks used in this book.

If you find a term you're not familiar with, refer to the glossary located in the back of this book.

An index follows the glossary.

## Related Publications

The *Setup Sheet* contains the instructions for unpacking, setting up, and cabling your server.

The *User's Handbook* provided with this manual contains detailed information about configuring, using, installing options in, and troubleshooting your server. See the “About This Book” section in the front of the *User's Handbook* for a description of what that book contains.

The *IBM PC Servers Hardware Maintenance Manual Supplement* is available for purchase. It contains a parts catalog, error codes, and advanced diagnostic procedures for PC Servers. This manual is intended for trained service technicians. (Diagnostic diskettes are not included.)

For a complete listing of publications available in the U.S. and Puerto Rico, call 1-800-426-7282. In Canada, call Customer Assistance at 1-800-465-1234. In all other countries, contact the IBM support organization that services your area, your IBM marketing representative, or your reseller.



# Chapter 1. Introducing Your IBM PC Server 320

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The IBM PC Server 320 is designed to meet your needs today and provide plenty of expansion capabilities for the future. Your system is a high-performance server, where microprocessor performance, memory, system expansion, flexibility, and large amounts of data storage are high priorities.

Your PC Server 320 is designed with performance, ease of use, and reliability in mind. Its advantages include *hot swapping* (the ability to install and remove hard disk drives without server downtime) and File Failure Prevention with NetFinity support from the ServerGuide package. Hot swapping is standard on some models, and is an optional upgrade on all other PC Server 320 models.

Your server is built around a powerful Intel Pentium microprocessor. You can install an optional second Pentium microprocessor. With an operating system that supports *symmetric multiprocessing (SMP)*, a second microprocessor can increase server performance.

As always, your IBM server meets stringent world wide certifications for power, electromagnetic compatibility (EMC), and safety.

## Introducing Your IBM PC Server 320



## Features at a Glance

<p><b>Microprocessor</b></p> <ul style="list-style-type: none"> <li>• Pentium microprocessor with 16 KB of internal cache</li> <li>• A processor upgrade, which adds another Pentium microprocessor, is available for symmetric multiprocessing</li> </ul> <p><b>Cache Memory</b></p> <ul style="list-style-type: none"> <li>• 256 KB of level-2 cache, upgradable to 512 KB</li> </ul> <p><b>Memory</b></p> <ul style="list-style-type: none"> <li>• Standard: 16 MB (min.), expandable to 256 MB of 70 ns parity</li> <li>• Eight 72-pin, single in-line memory-module (SIMM) sockets</li> <li>• Optional: 16 MB (min.), expandable to 256 MB of 70 ns error correction on SIMM (EOS)</li> </ul> <p><b>Diskette Drives</b></p> <ul style="list-style-type: none"> <li>• Standard: One 3.5-inch, 1.44 MB</li> <li>• Optional (internal):             <ul style="list-style-type: none"> <li>– 3.5-inch, 2.88 MB</li> <li>– 3.5-inch, 1.44 MB</li> </ul> </li> </ul> <p><b>Hard Disk Drives</b></p> <ul style="list-style-type: none"> <li>• <b>PCI/Micro Channel models:</b> <ul style="list-style-type: none"> <li>– Disk-array models support up to seven hard disk drives, six of them hot-swappable</li> <li>– Non-disk-array models support up to six hard disk drives, which are not hot-swappable</li> </ul> </li> <li>• <b>PCI/EISA models:</b> <ul style="list-style-type: none"> <li>– Disk-array models support up to eight hard disk drives, six of them hot-swappable</li> <li>– Non-disk-array models support up to seven hard disk drives, which are not hot-swappable</li> </ul> </li> </ul>	<p><b>CD-ROM Drive</b></p> <ul style="list-style-type: none"> <li>• Standard: SCSI-2 CD-ROM</li> </ul> <p><b>Keyboard and Auxiliary Device</b></p> <ul style="list-style-type: none"> <li>• 101-key keyboard</li> <li>• Mouse</li> </ul> <p><b>Expansion Bays and Slots</b></p> <ul style="list-style-type: none"> <li>• Hot-swap bays standard on some models; available on all models</li> <li>• Number of hot-swap bays varies by model</li> <li>• <b>PCI/Micro Channel models:</b> <ul style="list-style-type: none"> <li>– Two PCI slots</li> <li>– Six Micro Channel slots</li> <li>– Six 5.25-inch drive bays</li> <li>– One 3.5-inch drive bay</li> </ul> </li> <li>• <b>PCI/EISA models:</b> <ul style="list-style-type: none"> <li>– Two PCI slots</li> <li>– Five combination EISA/ISA slots</li> <li>– One shared PCI/EISA slot</li> </ul> </li> </ul> <p><b>Video</b></p> <ul style="list-style-type: none"> <li>• Super video graphics array (SVGA) controller</li> <li>• Compatibility:             <ul style="list-style-type: none"> <li>– Video graphics adapter (VGA)</li> <li>– Color graphics adapter (CGA)</li> <li>– Multicolor graphics array (MCGA)</li> </ul> </li> </ul> <p><b>Security Features</b></p> <ul style="list-style-type: none"> <li>• Bolt-down capability</li> <li>• Door lock</li> <li>• Administrator and power-on passwords (PCI/Micro Channel models)</li> <li>• Supervisor and user passwords (PCI/EISA models)</li> <li>• Selectable drive-startup</li> <li>• Security cover (optional)</li> <li>• LogicLock with active security (PCI/Micro Channel models)</li> </ul>	<p><b>Integrated Functions</b></p> <ul style="list-style-type: none"> <li>• Video connector (PCI/Micro Channel models)</li> <li>• Video port on an adapter (PCI/EISA models)</li> <li>• Two serial connectors</li> <li>• One parallel connector</li> <li>• Auxiliary device (mouse) connector</li> <li>• Keyboard connector</li> <li>• Battery-backed clock and calendar</li> <li>• SCSI-2 (PCI/Micro Channel models)             <ul style="list-style-type: none"> <li>– One 16-bit external connector</li> <li>– Two internal connectors (one 8-bit and one 16-bit)</li> </ul> </li> </ul> <p><b>SCSI-2 Controller</b></p> <ul style="list-style-type: none"> <li>• IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter (disk-array models only)             <ul style="list-style-type: none"> <li>– Two 16-bit internal connectors</li> <li>– One 16-bit external connector</li> <li>– Support for RAID levels 0, 1, and 5</li> </ul> </li> <li>• IBM SCSI-2 Fast/Wide PCI Adapter (PCI/EISA non-disk-array models)             <ul style="list-style-type: none"> <li>– One 16-bit internal connector</li> <li>– One 8-bit internal connector</li> <li>– One 16-bit external connector</li> </ul> </li> </ul> <p><b>Power Supply</b></p> <ul style="list-style-type: none"> <li>• 300 watt with manual range voltage selection (115–230 V ac)</li> <li>• Built-in overload and surge protection</li> </ul> <p><b>Upgradable POST and BIOS</b></p> <ul style="list-style-type: none"> <li>• Upgradable EEPROM on the system board</li> <li>• POST/BIOS upgrades (when available)</li> </ul>
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### What Your IBM PC Server 320 Offers

The PC Server 320 offers impressive performance using the Pentium microprocessor. You can install an optional second Pentium microprocessor for increased performance when used with an operating system that supports SMP. Your server also provides large data-storage capabilities, enhanced system expandability, and SVGA video graphics. This system is designed as a powerful, cost-effective server.

### IBM ServerGuide

The IBM ServerGuide package contains several compact discs (CDs). These CDs contain menu-driven programs that make it easy for you to install your operating system, network program, and systems-management software. These CDs also contain a performance tuning program. Refer to the documentation packaged with the ServerGuide CDs for more detailed information.

### IBM NetFinity

The IBM ServerGuide package gives you the option of installing IBM NetFinity. NetFinity is an integrated systems-management program that enables you to use several of the built-in systems-management features in your server. To find out more about NetFinity and how it can help you, view the demonstration program provided in the ServerGuide package and read its accompanying information.

### IBM PC Server Startup Support

The IBM PC Server Startup Support program provides comprehensive telephone assistance 24 hours a day, seven days a week during your first 90 days after installation.

IBM provides you direct access to trained specialists who can assist you with the setup, installation, and configuration of your server. Assistance is available for IBM and non-IBM network operating systems, network interface adapters, and other optional peripherals. To receive a current listing of the network products supported by the IBM PC Server Startup Support program, call the IBM Automated Fax System in the U.S. at 1-800-426-3395 and ask for

document number 16125. For more information about this exceptional program, or for assistance with the installation of your server:

- In the U.S., call 1-800-772-2227
- In Canada, call 1-800-565-3344
- In all other countries, contact the IBM support organization that services your area, your IBM marketing representative, or your reseller.

### PCI/Micro Channel Models

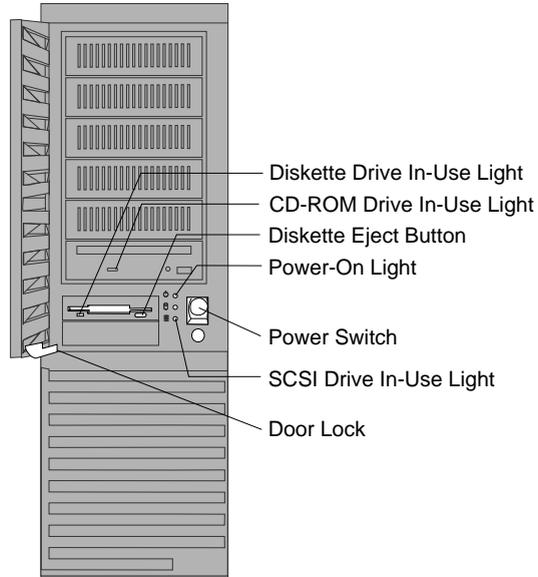
Combining the Micro Channel and peripheral component interconnect (PCI) bus architectures, these PC Server 320 models provide compatibility with a wide range of existing and future hardware devices and software applications. These bus architectures define the size, physical arrangement, and logical relationships of the connectors. The PC Server 320 multiple bus architecture provides a high speed, high throughput PCI local bus and the advanced Micro Channel expansion bus.

### PCI/EISA Models

Using both peripheral component interconnect (PCI) and extended industry standard architecture (EISA), these PC Server 320 models provide compatibility with a wide range of hardware devices and software applications. The EISA expansion slots support both EISA and industry standard architecture (ISA) devices.

## Controls and Status Indicators

The most commonly used controls and indicators are on the front of your server.



**Diskette-Drive In-Use Light:** This light comes on when the drive is accessing a diskette.

**CD-ROM Drive In-Use Light:** This light comes on whenever the CD-ROM drive is accessed.

**Diskette Eject Button:** Push this to release the diskette from the drive.

**Power-On Light:** This light comes on when you turn on your server.

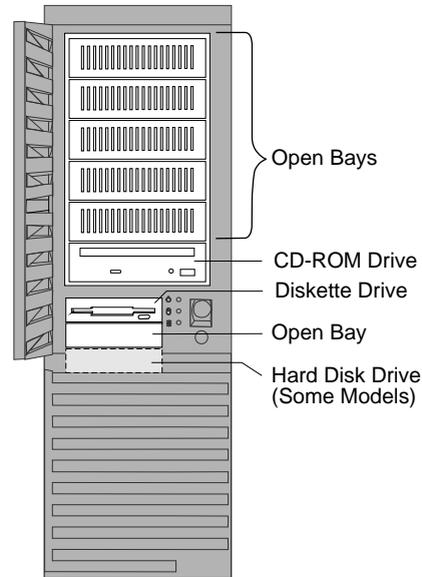
**Power Switch:** Press this to turn your server on or off. Do not turn off your server if any of the drive In-Use lights are on. This might damage the information stored on a hard disk or diskette.

**SCSI Drive In-Use Light:** This light comes on when your server is accessing a SCSI device.

**Door Lock:** Use the key to lock the door, to help prevent tampering with the internal components.

## Expansion Bays

Your server comes with one 3.5-inch, 1.44 MB diskette drive and a SCSI-2 CD-ROM drive. Some models also come with one or more hard disk drives.



**Open Bays:** Open drive bays give you the flexibility to use combinations of 3.5-inch or 5.25-inch hard disk, CD-ROM, tape, and rewritable optical drives in the non-disk-array models, and 1-inch or 1.6-inch (half-high) 3.5-inch hot-swap hard disk drives in the disk-array models. There is an additional open bay for a second 3.5-inch diskette drive or an additional hard disk drive. For installation instructions and information on the types of drives that you can install in each bay, see the “Installing Options” chapter in your *User's Handbook*.

**CD-ROM Drive:** All models come with a SCSI-2 CD-ROM drive.

**Diskette Drive:** The 3.5-inch, 1.44 MB diskette drive uses 1 MB and 2 MB diskettes.

**Hard Disk Drive:** The number of preinstalled drives and their capacities vary by model.

**Note:** See Chapter 5, “Data Storage Devices” on page 41, for more information on CD-ROM, diskette, and hard disk drives. For the latest information on available options, contact your IBM reseller or marketing representative.

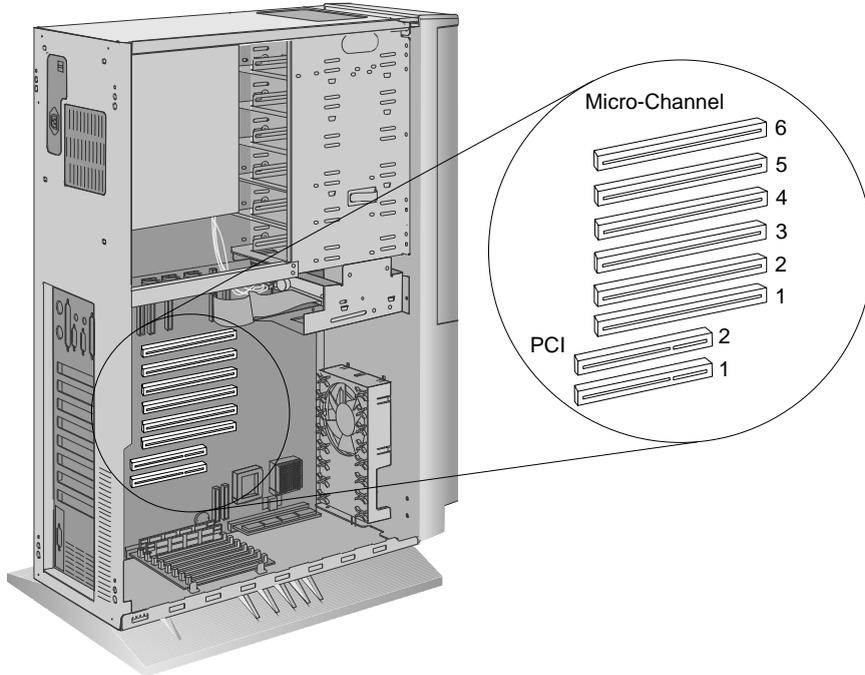
## Expansion Slots

The PCI/Micro Channel models of the PC Server 320 have six Micro Channel expansion slots and two PCI slots. The PCI/EISA models have six EISA expansion slots and three PCI slots.

On disk-array models, a SCSI-2 Fast/Wide PCI-Bus RAID Adapter is installed in one of the PCI slots.

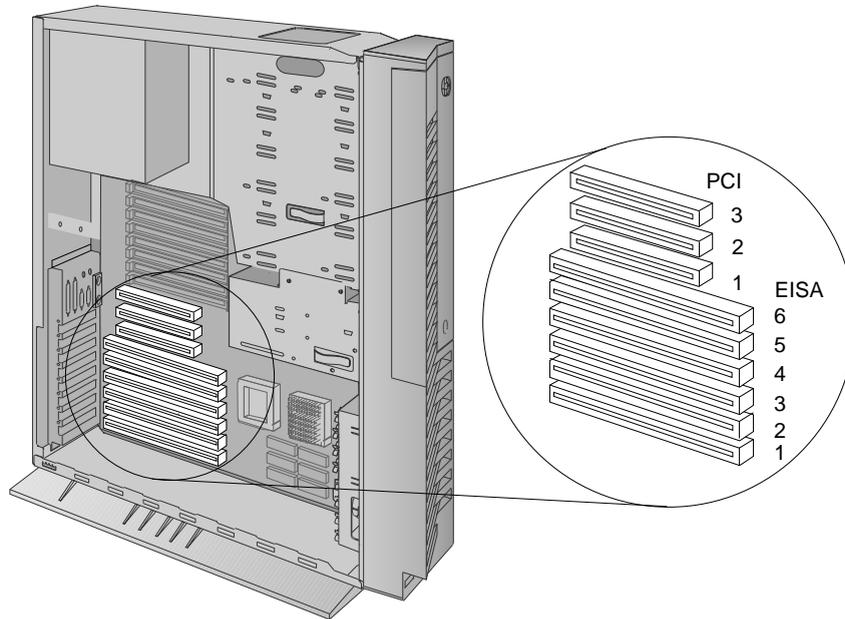
The remaining slots are available for future expansion. For example, you can add adapters to provide communications, specialized graphics, and sound. Many adapters provide bus-master capabilities, which enable the adapters to perform operations without interrupting the system microprocessor.

### PCI/Micro Channel Models



## PCI/EISA Models

On PCI/EISA models of the PC Server 320, the EISA and PCI slots closest to each other are called *shared* slots, meaning you can install one EISA or PCI device in either slot, but not both at the same time. (See the following illustration.)



*Note:* You also can install ISA devices in the slots designated as EISA slots.

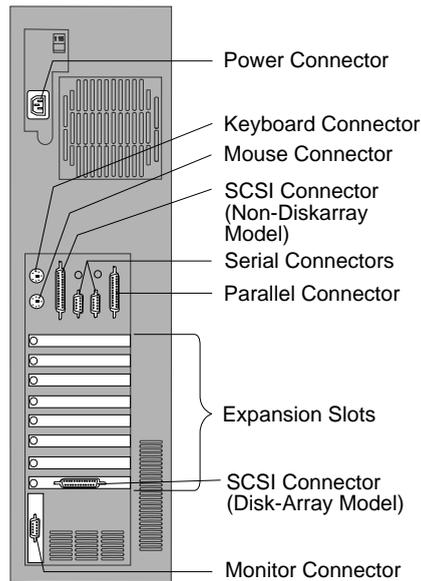
The video adapter is installed in an EISA slot. Your server comes with an IBM SCSI-2 Fast/Wide PCI Adapter or an IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter, depending on the model that you have purchased. These adapters are installed in a PCI slot.

## Input/Output Ports

PCI/Micro Channel and PCI/EISA models provide the same types of input/output ports (connectors). However, the arrangement of the connectors, which are located on the rear panel of your server, depends on which model you have purchased.

### PCI/Micro Channel Models

The following illustration shows the location of the input/output ports (connectors) on a PCI/Micro Channel model.



**Power Connector:** The power cable connects here.



**SCSI-2 Connector:** Attach external SCSI devices here.



**Monitor Connector:** The monitor signal cable attaches to this connector.



**Parallel Connector:** This is where the signal cable for a parallel printer or other parallel device connects to your server.



**Serial Connectors:** Two 9-pin serial connectors (A and B) are provided. The serial signal cable for a modem or other serial device usually connects here. If you are using a 25-pin signal cable, you need a 9-pin-to-25-pin adapter cable.



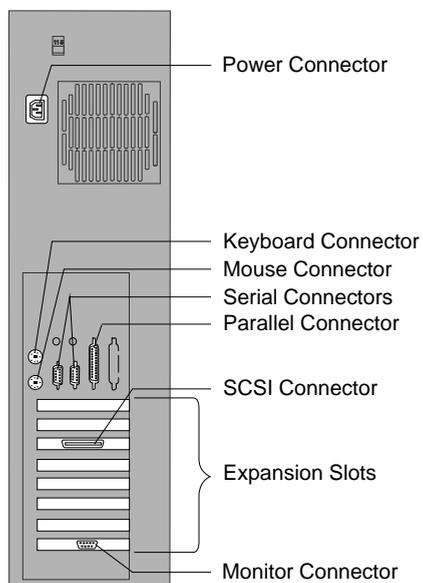
**Mouse Connector:** This is where the mouse cable connects to the server. This connector sometimes is called an auxiliary-device or pointing-device connector.



**Keyboard Connector:** The cable from your keyboard connects here.

## PCI/EISA Models

The following illustration shows the location of the input/output ports (connectors) on a PCI/EISA model.



**Power Connector:** The power cable connects here.



**Keyboard Connector:** The keyboard cable connects here.



**Mouse Connector:** The mouse cable connects here. This connector also is called an auxiliary-device or pointing-device connector.



**Serial Connectors:** Two 9-pin serial connectors (A and B) are provided. The serial signal cable for a modem or other serial device usually connects here. If you are using a 25-pin signal cable, you need a 9-pin-to-25-pin adapter cable.



**Parallel Connector:** One 25-pin parallel connector is provided. This is where the signal cable for a parallel printer or other parallel device connects to your server.



**SCSI Connector:** External SCSI devices attach here.



**Monitor Connector:** The monitor signal cable attaches to the connector on this adapter.

## International Capabilities

The IBM PC Server 320 is suitable for use worldwide. Electric power can vary from country to country; however, a switch enables you to switch voltage to the standard power available in your country. See your *User's Handbook* for information on switching voltages.

Language is another factor to consider. You can use your system with special editions of operating systems that let the system and keyboard operate with other languages. With the appropriate adapter, those same operating systems also let you view Asian characters on your monitor. Now you can use one system to communicate in many languages.



## Operating System Support

You can use the PC Server 320 in a variety of environments to do many different tasks. To meet the requirements of these environments, your server supports several different operating systems. Some operating systems, such as OS/2 2.1 or later, provide support for greater than 16 MB of memory. Check your operating-system documentation or contact your IBM reseller or marketing representative for more information.

OS/2 for SMP supports the dual-processing capability of your server. A second microprocessor is available as an upgrade.

# Specifications

<p><b>Size</b></p> <ul style="list-style-type: none"> <li>• With pedestal:             <ul style="list-style-type: none"> <li>- Depth: 473 mm (18.6 in.) 585 mm (23.0 in.) with cable cover</li> <li>- Height: 651 mm (25.6 in.)</li> <li>- Width: 315 mm (12.4 in.)</li> </ul> </li> <li>• Without pedestal:             <ul style="list-style-type: none"> <li>- Depth: 473 mm (18.6 in.) 585 mm (23.0 in.) with cable cover</li> <li>- Height: 622 mm (24.5 in.)</li> <li>- Width: 195 mm (7.7 in.)</li> </ul> </li> </ul> <p><b>Electrical Input</b></p> <ul style="list-style-type: none"> <li>• Sine-wave input (50 to 60 Hz) is required</li> <li>• Input voltage:             <ul style="list-style-type: none"> <li>- Low range:                 <ul style="list-style-type: none"> <li>- Minimum: 90 V ac</li> <li>- Maximum: 137 V ac</li> </ul> </li> <li>- High range:                 <ul style="list-style-type: none"> <li>- Minimum: 180 V ac</li> <li>- Maximum: 265 V ac</li> </ul> </li> </ul> </li> </ul>	<p><b>Environment</b></p> <ul style="list-style-type: none"> <li>- Air temperature:             <ul style="list-style-type: none"> <li>• System on: 10° to 35° C (50° to 95° F) Altitude: 0 to 914 m (3000 ft.)</li> <li>• System on: 10° to 32° C (50° to 90° F) Altitude: 914 m (3000 ft.) to 2133 m (7000 ft.)</li> <li>• System off: 10° to 43° C (50° to 110° F) Maximum Altitude: 2133 m (7000 ft.)</li> </ul> </li> <li>- Humidity:             <ul style="list-style-type: none"> <li>• System on: 8% to 80%</li> <li>• System off: 8% to 80%</li> </ul> </li> <li>- Maximum altitude: 2133 m (7000 ft)</li> </ul>	<p><b>Weight</b></p> <ul style="list-style-type: none"> <li>- Minimum configuration as shipped: 19.0 kg (42 lb)</li> <li>- Maximum configuration as shipped: 27.0 kg (59 lb)</li> </ul> <p>- Input kilovolt-amperes (kVA) approximately:</p> <ul style="list-style-type: none"> <li>- Minimum configuration as shipped: 0.07 kVA</li> <li>- Maximum configuration: 0.64 kVA</li> </ul> <p><b>Total Power Available for Drives</b></p> <ul style="list-style-type: none"> <li>• Nominal Operating Current allowed:             <ul style="list-style-type: none"> <li>- +5 V dc line: 9.3 A</li> <li>- +12 V dc line: 6.0 A</li> </ul> </li> </ul> <p><b>Heat Output</b></p> <ul style="list-style-type: none"> <li>• Approximate heat output in British Thermal Units (BTU) per hour:             <ul style="list-style-type: none"> <li>- Minimum configuration: 150 BTU (44 watts)</li> <li>- Maximum configuration: 1434 BTU (420 watts)</li> </ul> </li> </ul>
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## Reliability, Availability, and Serviceability

Three of the most important factors in server design are *reliability*, *availability*, and *serviceability* (RAS). These factors can help to ensure: the integrity of the data stored on your server; that your server is available when you want to use it; and that should a failure occur, you can easily diagnose and repair the failure with minimal inconvenience.

The following is a list of some of the RAS features of your PC Server 320. Many of these features are described in later chapters of this book, or in your *User's Handbook*.

- Menu-driven configuration programs
- Power-on self-test (POST) and Quick POST
- 24-hour customer support center
- Disk mirroring (some models)
- Hot-swap drive bays (some models)
- Menu-driven diagnostic programs
- Error codes and messages
- Upgradable POST and BIOS code
- Error correction on SIMM (EOS)
- Parity-protected memory
- Parity checking on the SCSI bus, Micro Channel bus, keyboard interface, and serial ports
- Vital product data (VPD) including serial number information and replacement part numbers, is stored in nonvolatile memory (PCI/Micro Channel models only)

## Introducing Your IBM PC Server 320

## Chapter 2. Understanding Server Performance

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Your productivity and satisfaction, as well as everyone else's on your network, depends upon server performance. Several factors can influence the performance of your server, such as the configuration of the server hardware, application workloads, server operating-system configuration parameters, and the server operating environment.

This chapter provides information to help you avoid potential performance bottlenecks and includes suggestions for improving server performance.

One of the main capabilities of a local area network is sharing of resources, such as data and expensive peripheral devices. The ability to share resources can mean a decrease in the cost of an individual workstation, because every workstation might not need its own software, printer, or hard disk. Sharing resources also can improve work flow, work quality, and productivity.

Some reasons for this are:

- Centralized databases can be shared easily.
- Security of information is more easily ensured.
- Meeting notices, notes, messages, letters, and text files can be sent to multiple users simultaneously, using electronic mail.

### **Integrated Systems Management**

The ServerGuide package that came with your server gives you the option of installing IBM NetFinity. NetFinity is a LAN management program that enhances the capabilities of your LAN. To find out more about NetFinity and how it can help you, view the demonstration program and read the information in the ServerGuide package.

### **Performance Tuning**

A performance tuning feature available on the ServerGuide CD (provided with your server) enables you to easily customize the programmable registers of your system so that your applications run faster than before. To improve the performance of your server,

## Understanding Server Performance

select **Performance Tuning** from the ServerGuide main menu and follow the instructions on the screen.

### Server Performance

You can optimize the performance of your server by balancing the performance of its main components. These components include the:

- Network operating system
- Application programs
- Network adapter
- System memory
- System microprocessor
- Hard disk subsystem (disk controller and drives)

### Network Operating System

Always check the documentation that comes with the network operating system to determine which parameters affect performance and which, if any, parameters you can change to increase performance. The original parameter settings provided by most network operating systems typically support a network with 12 to 18 concurrent users. If you have a larger network or increase the size of a network, you will probably need to adjust some of these settings to maintain adequate performance.

It's good practice to record the original settings before making any changes. If performance decreases, you can return the settings to their original values. It's also good practice to document changes by making remarks, such as the date and reason for the changes, above or below the values that you change. Such information can save you valuable time if you need to make additional adjustments.

### Application Programs

Most complex programs allow you to change specific parameters to improve performance in a network environment. Use the instructions that come with the application programs to determine which parameters to change and when and how to change them to affect performance.

It's good practice to record the original settings before you make any changes and, if possible, document the changes by making remarks above or below the values that you change.

### Network Adapter

Before you can use your server on a network, your server must have a network adapter installed. When you use a bus-master network adapter, the network throughput is less dependent on the type of system microprocessor and more dependent on the network adapter design and network software. The primary value of using a bus-master network adapter is added capacity or, in the case of a heavily loaded server, improved performance.

Bus-master network adapters are more suited for use in network servers. They provide higher throughput rates because they handle most of the network processing and leave the system microprocessor free for other tasks.

The appropriate network adapter for your server depends on the type of network your server is attached to (broadband, baseband, token-ring, or Ethernet). IBM and other companies offer baseband, broadband, token-ring, and Ethernet network adapters for PCI, EISA, and Micro Channel applications.

Adding a faster network adapter provides additional throughput. Therefore, the total number of transactions that the server processes per second increases and the application response time decreases. However, as you add more users, the effects of the faster network adapter are offset by the increase in data space access and write-data processing.

For a current list of the network adapters that are available for your model, contact your IBM reseller or marketing representative.

### System Memory

When you have a large network or you increase the size of a small network, you might need to install additional memory to maintain adequate performance. Additional memory might be needed to support additional application programs, buffers, or control blocks.

### System Microprocessor

One way to improve system microprocessor performance is to lighten its load by using bus-master adapters. Bus-master adapters handle tasks, such as the network processing or data transfers, with minimal microprocessor involvement.

You can install an additional Pentium microprocessor in the socket next to the system microprocessor. Used with an operating system that supports SMP, a second microprocessor can increase server performance.

### Hard Disk Subsystem

PCI/Micro Channel models have a SCSI-2 Fast/Wide Controller installed on the system board. This controller significantly increases performance by handling the processing of SCSI commands and data transfers, leaving the system microprocessor free to handle other tasks. This integrated controller supports up to 15 devices. You can install additional SCSI controllers for further expansion. You also can use SCSI storage enclosures to house additional devices.

PCI/Micro Channel disk-array models additionally contain an IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter. This RAID adapter is also a SCSI-2 controller and it supports up to an additional 14 SCSI devices.

PCI/EISA models come with either an IBM SCSI-2 Fast/Wide PCI Adapter for non-disk-array models, or an IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter for disk-array models. The IBM SCSI-2 Fast/Wide PCI Adapter supports up to 15 SCSI devices. The IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter supports up to 14 SCSI devices.

Disk arrays use multiple hard disk drives that provide faster input and output rates than a single large-capacity drive, because files are stored on individually addressable disks and can be found more quickly during read requests. The amount of performance improvement depends upon the application programs run on the server and the type of disk array that you define. (See Chapter 7,

“Disk-Array Subsystem” for more information about disk-array technology.)

All PC Server 320 disk-array models come with the IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter and the IBM Hot-Swap Bay option preinstalled. The Hot-Swap Bay option enables you to install up to six 1-inch high or three 1.6-inch high (half-high), 3.5-inch hot-swap hard disk drives in the server. Hot-swap drives enable you to replace hard disk drives without turning off the server.

## Estimating Server Performance and Capacity

There are no simple methods of evaluating server performance for all environments. The hardware, software, applications, workloads, and number of users all affect server performance.

When you are ready to do a performance evaluation, use a systematic approach. A good example of this approach follows:

1. Define the functional requirements of your server for your working environment.
2. Define what you consider to be adequate performance, such as response times, transaction rates, and number of users.
3. Understand what factors affect server performance.
4. Determine what is an approximate configuration of applications for your work environment.
5. Measure the current performance of your server using a variety of application configurations; then, use the performance results to locate performance bottlenecks and to determine which configuration provides sufficient performance today, and allows room for growth.
6. Ensure that the performance of the server will still be acceptable if a component fails.

### Improving Server Performance

Before you begin to experiment with applying upgrades or enhancements to improve performance, remember that the subsystem that causes a bottleneck depends largely on the applications that you are using.

Try to determine which applications most closely resemble your environment; concentrate on obtaining improvements for that application. It is possible that some changes might improve the performance of your application, but degrade the performance for other applications. If this occurs, you will need to assess the trade-offs.

When you understand the factors that affect server performance, you can then use a methodical approach to improving it. A good example of this type of approach is:

1. Measure the current server performance.
2. Identify the performance bottlenecks.
3. Upgrade components that cause the bottlenecks.
4. Measure the new performance of the server.

For example, if the bottleneck is memory, you could install additional memory; if the bottleneck is the hard disk subsystem, you could install an additional drive or create a disk array. You can replace slow network adapters with faster ones, or you can install additional adapters, and so on.

## Chapter 3. Microprocessors and Memory

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The processing center of your server contains devices that run programs and store data used by programs. These devices include the microprocessor and the components of the memory subsystem.

### Microprocessor

The *microprocessor* is an integrated circuit that performs most of the control and computing functions of your server. An Intel Pentium microprocessor is installed in your IBM PC Server 320.

The system board is equipped with a socket for an optional second Pentium microprocessor. You can increase server performance by installing a second microprocessor and an operating system that supports *symmetric multiprocessing (SMP)*, such as OS/2 for SMP.

*Note:* Operation of a dual processor system is transparent to adapters and application software. An operating system supporting SMP is not required if the second microprocessor is installed. If an optional second microprocessor is installed and the operating system does not support SMP, the server operates as a single-microprocessor (uniprocessor) machine.

### Microprocessor Clock

The rate at which the microprocessor performs its basic operations is called the *clock speed*. Examples of basic operations include fetching an instruction from memory, decoding it, executing it, writing the result to memory, and so on. The process of executing an instruction always consists of several basic operations. The design of the microprocessor determines the maximum clock speed at which it can operate reliably, and the design of the server determines the optimal clock speed for the server. Clock speed is measured in megahertz (MHz).

A *clock cycle* is the time unit that measures how long the microprocessor takes to perform a basic operation at a given clock speed. Clock cycles are measured in nanoseconds (ns) and are inversely related to the clock speed. For example, at a clock speed of 25 MHz, one clock cycle takes 40 ns; at a clock speed of 100 MHz, one clock cycle takes 10 ns. The microprocessor in your server operates at two different clock speeds: one speed for

## Microprocessors and Memory

transferring data into and out of the microprocessor; and a faster speed for internal microprocessor operations.

### Microprocessor Performance

The Pentium microprocessor gains its high performance through its *superscalar* design. The microprocessor contains three *execution units*; each execution unit can issue an instruction in one clock cycle. Each execution unit contains a *pipeline*. In a pipeline, multiple instructions are in various stages of execution. For example, while one instruction is fetched, two are decoded, another is executed, and the results of another are written to memory. This parallelism potentially speeds up instruction execution by a factor of 15 when compared to a microprocessor that is running at the same speed, but that does not use pipelining and multiple execution units.

In practice, the speedup is much less. In many clock cycles, the microprocessor does not issue an instruction. Memory accesses, even to very fast cache memory, take multiple cycles to finish. Some instructions spend many clock cycles in the execution stage of a pipeline. Still, performance is substantially improved.

### Microprocessor Registers and Interfaces

The microprocessor needs data or instructions, or both, for each basic operation. Instructions and data are copied from memory into data-storage locations, known as *registers*, in the microprocessor. The microprocessor can read from and write to its registers very quickly. Registers also store the results of processing operations until the results are needed for other operations or are written to memory.

The microprocessor *data interface* is the connection between the microprocessor and the data bus. The data interface of the microprocessor is 64 bits wide.

In PCI/Micro Channel models, both expansion buses in the server are 32 bits wide. These models support 32-bit PCI and Micro Channel adapters and 16-bit Micro Channel adapters. The 32-bit adapters transfer 32 bits of data at a time; the 16-bit adapters transfer 16 bits of data at a time.

In PCI/EISA models, the PCI expansion bus is 32 bits wide and the EISA bus is 16 bits wide. These models support 32-bit PCI adapters and 16-bit and 8-bit EISA adapters. The 32-bit PCI adapters transfer 32 bits of data at a time; the 16-bit EISA adapters transfer 16 bits of data at a time, and the 8-bit EISA adapters transfer 8 bits of data at a time.

The set of instructions that the microprocessor can perform determines whether a particular program will run in the server. Programs written for a 32-bit interface require only that the microprocessor be capable of decoding and performing 32-bit instructions. The width of the data bus does not affect software compatibility.

The size of the microprocessor *address interface*, which connects the microprocessor and the address bus, determines the width of the address bus and the amount of physical memory the microprocessor can address. The Pentium microprocessor in your server has a 32-bit address interface and can address up to 4 GB of physical memory. (One GB equals approximately 1 000 000 000 bytes.)

### Real Mode and Protected Mode Operation

The microprocessor has a *real mode* with a 1 MB address space. (One MB equals approximately 1 000 000 bytes.) When the microprocessor is in the real mode, your server can run programs written for earlier models of the IBM personal computer. The real mode is the default condition for the microprocessor; the microprocessor is always in the real mode after the server is turned on and before any operating system is started. The real mode does not support virtual memory (see “Physical Memory and Virtual Memory” on page 29).

The microprocessor also has a *protected mode*, which supports virtual memory and allows the microprocessor to address more than 1 MB of memory. In protected mode in a multitasking environment, the microprocessor manages the memory so that each program is protected from interference from other programs running at the same time.

## Microprocessors and Memory

The operating system you install determines whether the microprocessor stays in the real mode or is switched to the protected mode. For example, when the server runs DOS, the microprocessor stays in the real mode. DOS makes only limited use of the capabilities provided by the protected mode. When the IBM Operating System/2 (OS/2) operating system is started, it switches the microprocessor to the protected mode. The OS/2 operating system uses the virtual memory and multitasking capabilities provided by the protected mode of the microprocessor.

*Note:* The OS/2 operating system has a real mode and a protect mode. These operating-system modes are not related to the real mode and protected mode of the microprocessor.

### Numeric Computing

The microprocessor in your server has an execution unit that executes only floating-point arithmetic and mathematical instructions. This execution unit, called the *floating-point unit (FPU)*, executes the types of instructions previously executed by the separate math coprocessors used in earlier personal computers. These instructions, generally called *numeric instructions*, perform basic floating-point arithmetic and a variety of mathematical functions.

The control circuits of the microprocessor pass data and instructions to the FPU, which then performs the mathematical operations. The two other execution units, called *integer units*, can execute instructions concurrently with the FPU. The FPU is pipelined, so several floating point instructions can be in various stages of execution simultaneously.

Programs that require extensive mathematical calculations run much faster when the FPU performs the calculations, because the FPU is designed specifically for that purpose. A program that is intended to use the FPU must contain specific instructions that are recognized by the FPU. Otherwise, the program will not activate the FPU and the integer units will perform the calculations.

## Memory Subsystem

The *memory subsystem* consists of random access memory and read-only memory, physical memory and virtual memory, the memory controller, and cache memory.

### Random Access Memory and Read-Only Memory

Random access memory (RAM) is used for temporary storage of data and instructions during processing. RAM is contained in memory components known as *single inline memory modules* (also called *SIMMs*). It is *volatile* memory, which means that, to retain its contents, it must be constantly refreshed by an electrical current. While the server is turned off, no current is supplied to RAM, so no data is retained.

The system board has a small area of *nonvolatile* RAM. Using a small current from the system battery, nonvolatile RAM retains its contents while the server is turned off. It is used to store the power-on password, the supervisor or administrator password, the time and date, and system configuration information.

Read-only memory (ROM) stores programs that the server uses for startup procedures and other internal operations. These programs are permanently encoded in the ROM module. ROM is *nonvolatile* memory, and retains its contents when the server is turned off.

Generally, the contents of a ROM module cannot be modified. However, the type of ROM modules in your server can be reprogrammed. *Electrically erasable programmable ROM (EEPROM)* modules (or *flash memory*) can be reprogrammed while they are in the server. For example, the Power On System Test (POST) and the Basic Input Output System (BIOS) code in your server is stored in flash memory so that it can be updated whenever enhancements are made. The disk-array models also have an EEPROM on the SCSI-2 RAID adapter that stores disk array configuration information.

### Physical Memory and Virtual Memory

*Physical memory* consists of all the writable memory locations in the server, most of which are in single inline memory modules.

## Microprocessors and Memory

Portions of the physical memory are reserved for the operating system, for the power-on self-test, and for the video data that is being displayed. The part of physical memory available for instructions and data that the server uses to run programs is *system memory*.

You can add memory to your server by installing 4 MB, 8 MB, 16 MB or 32 MB single inline memory modules (SIMMs). Your server supports up to 256 MB of 70 ns parity memory. Optionally, you can install up to 256 MB of 70 ns error correction on SIMM (EOS) memory. EOS memory detects 1-bit memory errors and fixes them in real time, without reducing system performance.

You *cannot* use parity memory in combination with EOS memory. See your *User's Handbook* for more information about installing additional memory.

*Virtual memory* is memory that *appears* to be allocated to application programs. The operating system uses a portion of the hard disk as virtual memory, swapping data and instructions between the hard disk and physical memory. The portion of the hard disk used for virtual memory is often called *swap space*. The amount of swap space on the disk determines the amount of available virtual memory, which is typically much larger than the actual amount of installed physical memory.

Virtual memory supports very large programs and *multitasking*. In multitasking, multiple programs run simultaneously. The memory requirements of these programs can exceed the amount of available physical memory. The operating system allocates the memory required by each program as virtual memory and manages the available physical memory, swapping portions of each program's address space to the hard disk as required.

The maximum amount of virtual memory that an operating system can allocate is determined by the microprocessor and limited by the amount of available swap space. The microprocessor in your server can address up to 64 TB of virtual memory in the protected mode. (One TB equals approximately 1 000 000 000 000 bytes.)

### Memory Controller

The memory controller is a device that controls access to system memory by the microprocessor and I/O devices. Registers in the memory controller contain information about the amount and type of memory that is installed in the server. During a system reset, the POST routine writes this information into the registers.

### Cache Memory

*Cache memory* is high-speed memory that can respond to requests to read from or write to memory without imposing *wait states* on the microprocessor. A wait state is a clock cycle during which the microprocessor suspends processing and waits for a response to a request to read from or write to system memory (a *memory I/O operation*). Wait states cause the server to operate less efficiently than it would if the microprocessor did not suspend processing. Using cache memory is another method of reducing the need for wait states. It improves server performance by temporarily storing frequently used data and instructions in a *cache*, a relatively small buffer between the microprocessor and system memory.

The system board in your server contains level-1 and level-2 caches. Cache performance depends on the size of the cache and the application programs you are running on your server.

#### *Level-1 Cache*

The level-1 cache is implemented as an area of very fast RAM on the microprocessor. This type of cache memory is also referred to as an internal cache. A Pentium microprocessor provides 16 KB of level-1 cache memory: 8 KB for data and 8 KB for instructions. (One KB equals approximately 1000 bytes.)

The level-1 cache stores the data and instructions most frequently used by the microprocessor in the current execution context. (The execution context is the executable code and associated data used by the program running on the microprocessor.) Because the microprocessor sends many fewer read and write requests to system memory, a level-1 cache enables a microprocessor to execute programs much faster than if it had to access system memory for each request. When the execution context changes, the level-1 cache

## Microprocessors and Memory

controller copies new data and instructions into the cache, replacing data and instructions that are no longer needed.

Server performance improves each time the microprocessor finds what it needs in the cache (a *cache hit*). The microprocessor is designed so that the cache hit rate is very high, and the penalty for a *cache miss* is minimized. A cache miss occurs when the information needed by the microprocessor is not available in the cache. In the case of a cache miss, the level-1 cache controller must request the needed data from the level-2 cache or system memory. One or more wait states are imposed on the microprocessor while the data is located. The cache controller on the microprocessor manages the use of the cache so that the number of cache hits far exceeds the number of cache misses.

### *Level-2 Cache*

The system board in your server has a 256 KB level-2 cache. The level-2 cache consists of high-speed static random access memory (SRAM). The level-2 cache provides an intermediate level of storage between the level-1 cache and system memory. Although level-2 cache accesses are slower than level-1 cache accesses, level-2 cache accesses are still much faster than system memory accesses.

In the case of a level-1 cache miss, the microprocessor can access the level-2 cache relatively quickly. If the microprocessor does not find what it needs in the level-2 cache (a *second-level cache miss*), the cache controller locates the data or instruction in system memory and copies it into one of the caches.

### *Write-Back Mode*

For maximum performance, both PC Server 320 caches are set to the write-back mode. In the write-back mode, the microprocessor updates the cache in just over one clock cycle. After the microprocessor updates the cache, the cache controller updates system memory. The microprocessor is free to perform other operations while the cache controller updates system memory. Because the cache controller updates system memory, which is a relatively lengthy process, the microprocessor is free to execute instructions.

## Chapter 4. Bus Architecture

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A *bus* is an electrical pathway for transferring signals and power among microprocessors, memory, adapters, and I/O devices. The signals include addresses, data, and control information.

Your PC Server 320 provides a multiple bus architecture. A peripheral component interface (PCI) bus provides a high-throughput local bus, and an EISA or Micro Channel bus provides an expansion bus that supports PC compatibility and a wide range of adapters.

### PCI Bus Overview

The PCI bus is a local bus, intended for interconnecting a system microprocessor with tightly-coupled peripherals and memory. A local bus becomes a system requirement as microprocessor speeds increase. In previous systems, bus performance more closely matched microprocessor performance. As microprocessor performance improves, the microprocessor spends too much time waiting for I/O to move across the relatively slow system bus. A local bus is much more tightly coupled to the system microprocessor, and its speed much more closely matches the microprocessor's.

PCI architecture uses the burst mode for all transfers. PCI supports a 132 megabyte-per-second (MBps) peak transfer rate for 32-bit PCI devices and a 264 MBps peak transfer rate for 64-bit PCI devices. The current design supports PCI bus speeds up to 33 MHz.

Examples of devices that might be attached to a local bus include:

- Video controllers
- Disk controllers
- High-speed network interface adapters

### EISA Bus Overview

One of the benefits of EISA is that it allows you to install and use both EISA and ISA adapters and the devices that they support.

The EISA Configuration program, supplied with your PCI/EISA model, automatically detects and configures EISA adapters. On

## Bus Architecture

most ISA adapters, you must set switches and jumpers. The program assists you in determining the necessary switch and jumper settings.

Data transfers on the EISA bus are synchronized to an 8.33 MHz bus clock signal. On the EISA bus, *if the target device supports EISA burst-mode transfers*, the data transfer requires only one cycle of the bus clock.

Because the data path on the EISA bus is 32-bits wide, four bytes of data (maximum) can be transferred during each data transaction. This allows a maximum data transfer rate of 33.32 MBps.

### ISA Bus Overview

Data transfers on the ISA bus are synchronized to an 8 MHz (more typically 8.33 MHz) bus clock signal. If the target device is a zero-wait-state device, the data transfer requires a minimum of two cycles of the bus clock. This results in a data transfer rate of 4.165 MBps.

Because the data path on the ISA bus is only 16-bits wide, two bytes of data (maximum) can be transferred during each data transaction. This allows a maximum data transfer rate of 8.33 MBps.

### Micro Channel Bus Overview

In your server, the Micro Channel bus serves as an expansion bus supporting Micro Channel adapters.

### PCI and Micro Channel Shared Features

The PCI and Micro Channel architecture implementations in some PC Server 320 models share some fundamental features. Adapters for both buses are automatically configured by the server. Configuration programs and files assign interrupt levels, I/O addresses, memory addresses, arbitration levels, and other resources.

Both buses are implemented as 32-bit buses in these models. Both have 32 signal paths for data; 32 bits of address or data can be sent across each bus simultaneously.

Both buses support burst data transfers; an address and multiple data words (each containing 32 bits) can be sent in each transfer. The address specifies the location of the data to be sent; a bus command specifies the number of data words to send.

Each bus supports data transfers from only one device at a time. A *bus arbitration* mechanism determines which device can access a bus at a given time.

Both buses have several functions; each is used as an expansion bus, an address bus, and a data bus.

### Expansion Bus

An expansion bus supports the addition of adapters to add new functions to your server. Adapters plug into connectors, called *expansion slots*, on the system board.

The PCI expansion bus provides two connectors for adapters; the Micro Channel architecture expansion bus provides six connectors. These connectors provide paths for transferring data to and from the adapters.

### Address and Data Bus

When a device sends data, it identifies where the data is stored (source) and where it is to be sent (destination). Each location is identified by a unique number, known as an *address*. Each memory location and I/O device that is attached to the bus has an address. The sending device uses the bus as an address bus to send the target address to the receiving device. Then the sending device uses the bus as a data bus to send the data.

The width of a bus determines the size of the address space available to the bus. The PCI and Micro Channel architecture buses each have a 32-bit address bus, enabling devices on the bus to address up to 4 GB of memory.

## Bus Architecture

The width of the data bus determines how much data can be transferred simultaneously. PCI, as implemented in the PC Server 320, provides a 32-bit data path. The Micro Channel architecture as implemented in some models of the PC Server 320, provides data-bus widths of 8, 16, and 32 bits, depending on the capacity of the sending and receiving devices. For example, when a 32-bit device transfers data to an 8-bit device, the 32-bit device must send the data in four 8-bit transfers. Only when both the sending device and the receiving device are 32 bits wide is the full width of the 32-bit data bus used.

In PCI/Micro Channel models, the PCI bus connects to the Micro Channel bus through a *bridge*, a hardware component that provides a path between the system microprocessor, the PCI bus, and the Micro Channel bus.

### Bus Master Implementation

Both the PCI bus and the Micro Channel architecture bus support *bus masters*. A bus master is an on-board device or controller, or an adapter, that can take control of (own) the bus. The system microprocessor is the first owner of the bus at system start-up. Other bus masters receive ownership of the bus by halting the system microprocessor.

A bus master can have its own microprocessor, instruction cache, and memory. By taking over some of the work of the system microprocessor, bus masters create a multiprocessing environment and increase overall system performance.

Typical bus masters include:

- Memory and cache controllers
- Disk controllers
- Direct memory access (DMA) controllers
- Video controllers and adapters
- Network interface adapters

Once a bus master has control of the bus, it can issue bus commands to other devices on the bus. The target of a bus master, called a *subordinate*, executes bus commands issued by a bus master.

Subordinates can initiate service requests, such as interrupts, but subordinates never own the bus.

A bus master can also be a subordinate, but, at a given time, it must be either a bus master or a subordinate. It cannot be both simultaneously.

### Bus Arbitration

The PCI and Micro Channel bus architectures support arbitration, a process that determines which of two or more competing devices has control of the bus at any given time. When multiple devices need to own a bus at the same time, these devices participate in *arbitration*.

The PCI and Micro Channel architectures each implement a *central arbitration control point*. This is where contending devices send their arbitration signals. The central arbitration control point does not actually decide which device should control the bus; contending devices make that determination among themselves, using arbitration logic that is programmed into the devices. However, it is the central arbitration control point that actually grants control after the decision is made.

Every Micro Channel device that can arbitrate for control of the bus is assigned a priority level, known as an *arbitration level*, that is used to determine which device should control the bus next. The arbitration level for each device is contained in a software file, known as an *adapter description file (ADF)*.

*Note:* Devices that contend for control of a bus must not have the same arbitration level. Occasionally, arbitration-level conflicts occur between devices. When this occurs, you can use the system programs to change the arbitration level of one of the conflicting devices.

Both buses have *fairness features* to ensure that all devices get a turn to own the bus, even those devices having low priority levels. The fairness feature guarantees that none of the devices are locked out of the bus and that each device can gain control of the bus within a given amount of time.

## Bus Architecture

When you configure the server, you can disable the fairness feature for a Micro Channel device so that it controls the bus more than other devices. A device for which fairness has been disabled can monopolize the bus. Disabling the fairness feature for more than one device is risky. You could cause some devices for which the fairness feature is enabled to be completely locked out of the bus, including the microprocessor. Therefore, it is best to leave the fairness feature enabled for all devices.

### Bus-Parity Checking

The PCI and Micro Channel buses support *bus parity checking*, a method of verifying that data has not been changed during a data-transfer operation. Bus parity checking uses an extra bit, known as a *parity bit*, that is sent with each byte of data as it is transferred across the bus. The parity bit is set to 1 or 0 so that each byte has an odd number of 1s (if the server uses odd parity) or an even number of 1s (if the server uses even parity). If the parity (odd or even) of the received byte does not match the parity of the byte as it was sent, an error occurred during transmission and the receiving device can request that the data be sent again.

Bus parity checking is a common feature in servers. It is not 100% accurate, but it greatly reduces the chance for errors. It is essential for most operations because of fast I/O devices, complex I/O configurations, and large memory subsystems.

### Features Unique to the Micro Channel Bus

The Micro Channel bus provides features not implemented in the PCI bus. These include:

- Direct memory access (DMA)
- Streaming-data procedure
- Channel-check reporting and error logging

### Direct Memory Access

*Direct memory access (DMA)* is used to transfer large amounts of data between system memory and I/O devices without the intervention of the microprocessor. DMA is more efficient than *programmed I/O*, in which the microprocessor reads the data from the sending device

and then writes it to the receiving device. In DMA data transfers, data can bypass the system microprocessor as it moves between system memory and I/O devices. DMA improves server performance because the microprocessor does not need to interrupt its processing activities to manage data transfers.

The *DMA controller* is a bus master that manages data transfers between DMA subordinates and memory subordinates. Transferring data between system memory and an I/O device requires two steps. Data goes from the sending device to the DMA controller and then to the receiving device. The microprocessor gives the DMA controller the location, destination, and amount of data that is to be transferred. Then, the DMA controller transfers the data, allowing the microprocessor to continue with other processing tasks.

When a device needs to use the Micro Channel bus to send or receive data, it competes with all the other devices that are trying to gain control of the bus.

### Streaming-Data Procedure

The *streaming-data procedure* allows high-speed data transfers between bus masters and subordinates. This procedure supports high-speed transfers of large blocks of data for devices such as disk controllers and network adapters.

The streaming-data procedure transfers blocks of sequentially stored data. In basic data-transfer operations, a target address is assigned for every byte of data that is transferred. The streaming-data procedure assigns a target address only to the first byte of data; the rest of the data in the block follows in sequence and is assigned to sequential addresses. A streaming-data transfer operation takes 100 nanoseconds to send 4 bytes of data. This is a data-transfer rate of 40 megabytes per second, which is twice as fast as basic data-transfer operations.

The Micro Channel bus has 32 data lines and 32 address lines. During streaming-data transfer operations, the 32 address lines are used only at the beginning of a transfer cycle. Then they remain idle for the rest of the cycle. The multiplexed streaming-data

## Bus Architecture

procedure uses the address bus as another 32-bit data bus, allowing data to be transferred 64 bits at a time.

## Chapter 5. Data Storage Devices

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IBM data storage devices and IBM external storage enclosures are available for the PC Server 320. You can use these storage devices, along with a wide variety of industry standard storage devices, to expand the data storage capacity of your server.

*Note:* Some storage devices described in this chapter are not supported in all IBM PC Server 320 models. See your *User's Handbook*, or contact your IBM reseller or marketing representative, for more information.

### The SCSI Controller

All PC Server 320 models come with an integrated SCSI-2 controller or a preinstalled SCSI-2 adapter connected to a SCSI-2 CD-ROM drive. You can connect additional SCSI devices of various types, including hard disk drives, optical drives, and tape drives to the SCSI-2 controller or SCSI-2 adapter.

#### *PCI/Micro Channel Models*

The PCI/Micro Channel system board has an integrated SCSI-2 Fast/Wide controller. This integrated controller supports up to 15 devices, and it has an 8-bit internal connector, a 16-bit internal connector, and a 16-bit external connector. You can attach SCSI devices to only two of these connectors simultaneously. The internal connectors enable you to connect SCSI devices that you install inside your server to the SCSI interface. The external connector enables you to attach external SCSI devices, such as an IBM SCSI storage enclosure, to the SCSI interface.

Disk-array models also come with an IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter preinstalled. This RAID adapter is also a SCSI-2 controller, and it supports up to 14 SCSI devices. The RAID adapter provides three additional SCSI-2 connectors: two 16-bit internal connectors and one 16-bit external connector. You can attach SCSI devices to only two of these connectors simultaneously, but not the 8-bit internal connector and the 16-bit internal connector simultaneously.

#### *PCI/EISA Models*

The PCI/EISA models come with either an IBM SCSI-2 Fast/Wide PCI Adapter or an IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter.

## Data Storage Devices

The IBM SCSI-2 Fast/Wide PCI Adapter supports up to 15 devices, and it has an 8-bit internal connector, a 16-bit internal connector, and a 16-bit external connector. The IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter supports up to 14 devices, and it has two internal 16-bit connectors and one external 16-bit connector.

The internal connectors on these adapters enable you to connect SCSI devices that you install inside the server to the SCSI interface. The external connectors on these adapters enable you to attach external SCSI devices, such as an IBM SCSI storage enclosure, to the SCSI interface. (For more information about SCSI storage enclosures, see “IBM External SCSI Storage Enclosures” on page 44.) The PC Server 320 supports drives that comply with ANSI SCSI Standards X3.131-1986 or X3.131-1994.

### *Disk-Array Models*

All PC Server 320 disk-array models come with the IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter and the IBM Hot-Swap Bay option preinstalled. The Hot-Swap Bay option enables you to install up to six 1-inch high or three 1.6-inch high (half-high), 3.5-inch hot-swap hard disk drives in the server. Hot-swap drives enable you to replace hard disk drives without turning off the server.

## IBM Direct Access Storage Devices

In a *direct access storage device (DASD)*, the time required to access data does not depend on the location of the data on the storage medium. These devices include diskette drives, hard disk drives, CD-ROM drives, and rewritable optical drives.

### Diskette Drives

The PC Server 320 supports two diskette drives: the 3.5-inch 1.44 MB (standard in your server) and the 3.5-inch 2.88 MB. Both are also available for purchase as options.

#### *3.5-Inch 1.44 MB Diskette Drive*

This drive, standard in your PC Server 320, uses 3.5-inch diskettes with a formatted capacity of 720 KB, or 1.44 MB. To prevent the

loss of data, always format 1 MB diskettes to store 720 KB of data and 2 MB diskettes to store 1.44 MB of data.

### *3.5-Inch 2.88 MB Diskette Drive*

This optional drive uses 3.5-inch diskettes with a formatted capacity of 720 KB, 1.44 MB, or 2.88 MB. To prevent the loss of data, always format 1 MB diskettes to store 720 KB of data, 2 MB diskettes to store 1.44 MB of data, and 4 MB diskettes to store 2.88 MB of data.

## SCSI Hard Disk Drives

IBM offers a variety of hard disk drives of various capacities and performance capabilities.

*Note:* The number of hard disk drives that your server can support is determined by your operating system. Refer to your operating-system documentation or contact your place of purchase to determine the number of hard disk drives that your operating system supports.

## SCSI CD-ROM Drive

*Compact disc-read only memory* (CD-ROM) drives use a compact disc (CD) that the system can read from but not write to. Data can be viewed but not updated or changed. While diskette drives, hard disk drives, and tape drives use a magnetic recording technique, CD-ROM drives use an optical technique that holds data at a much higher density than magnetic recording can achieve. All IBM CD-ROM drives use industry-standard 5.25-inch CDs with formatted capacities of approximately 680 MB of data.

IBM CD-ROM drives comply with ANSI SCSI Standards X3.131-1986 or X3.131-1994 (SCSI-2). They support CD-ROM Extended Architecture (XA), a standard for interleaving different types of data, such as video, audio, and text. This provides you with the option of expanding your system to work with advanced multimedia applications.

### Tape Drives

Tape drives are sequential-access devices that provide an excellent, cost-effective way to back up the important data on your server. In a sequential-access (or serial-access) device, data is stored in the storage medium in the same sequence as it was entered. Contact your IBM reseller or marketing representative for more information about the tape drives available for the PC Server 320.

### IBM External SCSI Storage Enclosures

A SCSI storage enclosure is used to increase the data-storage capacity of any server that has a SCSI controller.



An example is the Model 3516 Hot-Swap Storage Expansion Enclosure, a mini tower that holds up to seven hot-swap hard disk drives. It is shipped without drives, so you must install at least one drive before you attach the enclosure to the server. To connect the enclosure to the external SCSI-2 connector on the server, you need a 68-pin to 68-pin external SCSI-2 cable.

The manual provided with the enclosure includes information about setting it up, installing and removing drives, and attaching the enclosure to the server.

## Chapter 6. SCSI Subsystem

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Your PC Server 320 comes with a *small computer system interface* (SCSI) controller. Your server uses the SCSI interface to communicate with devices such as hard disk drives, read-and-write optical drives, CD-ROM drives, tape drives, scanners, and printers.

In PCI/EISA models, the SCSI controller is an adapter: either the IBM SCSI-2 Fast/Wide PCI Adapter (referred to as the SCSI adapter) or the IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter (referred to as the SCSI RAID adapter). (RAID is an acronym for *redundant array of independent disks*).

PCI/Micro Channel models contain an integrated SCSI controller located on the system board. Disk-array models also have a SCSI RAID adapter installed in a PCI expansion slot. When a SCSI RAID adapter is installed, it and the integrated SCSI controller operate independently.

### Advantages of the SCSI Subsystem

Before the SCSI standards were developed, many physical devices required controllers (usually adapters) that could support only one device or multiple devices of the same type. Because each device required support from the system microprocessor, every device added to the system increased the workload on the microprocessor. Also, because almost every device required its own adapter in a separate expansion slot, flexibility and growth were limited by the number of expansion slots in the system.

The SCSI standards define the interface (SCSI) through which the system communicates with different types of devices. Each SCSI device has a built-in *device controller* that interprets SCSI commands. The SCSI standards define the commands and messages used in the interface.

Several SCSI devices can operate concurrently and share the interface, achieving significantly higher data-transfer rates. Faster, more efficient, I/O management for network file servers can be realized using the SCSI subsystem. The SCSI subsystem produces significant improvements in system performance and flexibility over other I/O interfaces.

## SCSI Subsystem

You can connect internal and external physical devices to the same SCSI controller. The integrated SCSI controller, the SCSI adapter, and the SCSI RAID adapter each have internal and external connectors.

The SCSI controller and SCSI adapter support up to a total of 15 SCSI devices. You can attach up to seven 8-bit devices to the internal, narrow connector. If there are no devices attached to the internal narrow connector, you can attach up to fifteen 16-bit and 8-bit SCSI devices to the internal, wide connector or to the external, wide connector.

*Note:* An 8-bit to 16-bit converter is required to attach an 8-bit (narrow) device to a 16-bit (wide) cable.

The SCSI RAID adapter supports up to 14 physical devices. The SCSI RAID adapter has two wide, internal connectors and one wide external connector. If you use both internal connectors, you cannot use the external connector.

The integrated controller, the SCSI adapter, and the SCSI RAID adapter support:

- SCSI devices that conform to American National Standards Institute (ANSI) SCSI Standard X3.131-1986 or X3.131-1994 (SCSI-2)
- Up to fifteen 16-bit (14 for the SCSI RAID adapter) and 8-bit SCSI devices
- Devices compatible with the SCSI Common Command Set
- Functions that are unique to a particular SCSI device, when they are supported by a specific device-driver provided by the device manufacturer

## Types of Interfaces

The two most common types of interfaces for attaching devices to a server are *device-level* interfaces and *bus-level* interfaces.

## Device-Level Interfaces

Each device connected to a device-level interface has a controller that is mounted on a separate adapter, away from the physical device. Functions such as formatting, head selection, and error detection are directed by the controller and not by the device itself. The device is limited to performing the mechanical operations of reading and writing data, and it can do only what the controller allows it to do. There are limitations on the types of devices you can attach to the same controller.

## Bus-Level Interfaces

Each device connected to a bus-level interface has a *device controller* that provides the details of how to accomplish the tasks performed by the device. The SCSI is a bus-level interface. A set of commands, the Common Command Set, specifies the tasks that devices are to perform. Each device controller determines how the tasks should be performed. The SCSI controller imposes few restrictions on the number and types of devices that you can attach to it.

The SCSI standard allows great flexibility in the design of devices. Hardware manufacturers can develop SCSI devices to perform functions without requiring that the SCSI controller support those functions. Functions unique to a particular SCSI device are supported by the device driver provided by the device manufacturer. As new SCSI devices become available, there is no need to install new adapters. You can attach many different devices, such as hard disk drives, CD-ROM drives, scanners, and printers, to the same SCSI controller.

## SCSI Physical Configuration

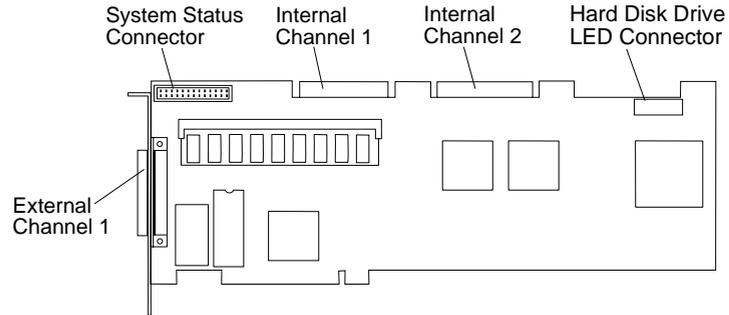
The following describes a possible configuration of the SCSI subsystem in a PC Server 320.

- In PCI/Micro Channel models, the integrated SCSI controller provides one external, wide connector (sometimes called the SCSI-2 port); and two internal connectors, one wide and one narrow.

## SCSI Subsystem

- In PCI/EISA models, the SCSI-2 controller (on a PCI adapter) is connected to the PCI bus.
- SCSI devices are attached to a SCSI connector by a cable. This can be a SCSI cable inside the system that provides connectors for internal devices, or a SCSI cable (or series of cables) that connects to the external SCSI-2 connector.
- You can attach up to 15 internal and external devices to the integrated SCSI controller or SCSI adapter. The SCSI RAID adapter supports up to 14 physical devices.
- If any SCSI device connected to the controller has a data transfer rate faster than 5MB/second, the maximum length of the SCSI bus (cable) must not exceed 3 meters (approximately 10 feet). Otherwise, the maximum bus length is 6 meters (approximately 20 feet). These lengths include internal and external cables. Following these standards will ensure proper server operation.
- The first external device is connected to an external SCSI cable, which connects to the external SCSI-2 connector. (On PCI/EISA models, the external SCSI-2 connector is a 68-pin connector on the adapter.) Additional external devices are connected to each other with SCSI option-to-option cables. The last external device must have a terminator; if there is only one external device, it must have a terminator. See “Termination” on page 52 for more information.
- For the integrated SCSI-2 controller and the SCSI adapter, one internal connector is for an 8-bit cable, and the other internal connector is for a 16-bit cable. You can attach SCSI devices to only two of the three connectors simultaneously, but not the 8-bit internal connector with the 16-bit internal connector.

For the SCSI-2 RAID adapter, both internal connectors and the external connector are for 16-bit cables. You can attach SCSI devices to any two of the three connectors simultaneously, but not the internal channel 1 connector with the external channel 1 connector. The following illustration shows the location of the connectors on the SCSI-2 RAID adapter.



*Note:* Each device attached to the interface must conform to ANSI SCSI Standard X3.131-1986 or X3.131-1994 (SCSI-2). These standards specify the mechanical, electrical, and functional requirements and the command sets that must be used by devices in the SCSI subsystem.

### SCSI Device IDs

The SCSI ID is also known as the *SCSI address* or *physical unit number (PUN)*.

Each SCSI device must have a unique SCSI ID. The unique ID prevents two devices from sending data to the same SCSI controller at the same time. SCSI devices use a variety of mechanisms to set the SCSI ID, such as jumpers, thumbwheels, or switches. Devices attached to a wide connector can use IDs 0 through 15, except 7, which is reserved; devices attached to the narrow connector can use SCSI IDs 0 through 6 only.

The integrated SCSI-2 controller (or SCSI-2 adapter) is always preset to ID 7. Removable-media read and write devices, such as tape drives, should be assigned higher IDs than hard disk drives, which operate at a higher priority.

The SCSI-2 RAID adapter supports two sets of SCSI IDs 0 through 7. (SCSI ID 7 is reserved for the controller, however.) Devices that are attached to one cable can use SCSI IDs 0 through 6. Devices that are attached to another cable also can use SCSI IDs 0 through 6. The hard disk drives in the hot-swap bay option are automatically assigned SCSI IDs 0 to 5 from the top to the bottom of the bay.

## SCSI Subsystem

When more than one physical device is connected to the same SCSI-2 controller, the devices compete for support from the SCSI-2 controller. Because the SCSI-2 controller communicates with only one device at a time, the priority of a device is based on the ID of the device.

In summary, SCSI IDs perform two functions:

- They allow the SCSI controller to distinguish one device from another.
- They allow the SCSI controller to determine the priority of each device.

### SCSI Logical Unit IDs

Each device also supports at least one *logical unit number (LUN)*. Most SCSI devices support only LUN 0. Certain types of physical SCSI devices (*bridge controllers*) can support more than one logical unit (device).

For example, a printer controller might support up to eight printers. The LUN identifies each device (printer) that is connected to the SCSI through its own device controller (the printer controller).

In this example, the printer controller is a physical device, and each printer is a logical device. If the printer controller is assigned to ID 6, the ID of the first printer appears in the SCSI device configuration as PUN 6, LUN 0. The IDs of the other printers are PUN 6, LUN 1; PUN 6, LUN 2; and so on. Each physical device has a PUN and a LUN, whether or not it supports more than one logical device. If a physical device supports no logical devices, its LUN is 0.

When more than one physical device is connected to the same SCSI controller, the devices compete for support from the SCSI controller. Because the SCSI controller communicates with only one device at a time, the priority of a device is based on the ID of the device.

For the SCSI subsystem to function properly:

- The SCSI controller must remain set to ID 7.

- In non-disk-array models, the SCSI hard disk drive that starts your server is set to ID 6. For disk-array models, the SCSI hard disk drive that starts your server is set to ID 0.
- In disk-array models, the SCSI IDs of hot-swap hard disk drives is set automatically.
- In non-disk-array models that have devices attached to the 16-bit internal cable, and the 16-bit external connector, you can assign IDs 8 through 15. An 8-bit cable supports SCSI IDs 0 through 7 only.
- Removable-media read and write devices, such as tape drives, should be assigned lower IDs than hard disk drives, which operate at a higher priority.
- After you choose an ID for a non-hot-swap device, physically set the ID on the device (usually with switches or jumpers) as required. Follow the instructions that are supplied with the device.

### Cabling

An interface that conforms to the SCSI narrow standard consists of a set of eight data lines, one data-parity line, and various control lines. For cables that support SCSI wide devices, the interface consists of a set of 16 data lines, two data-parity lines, and various control lines.

The IBM SCSI-2 Fast/Wide PCI Adapter and the integrated SCSI-2 controller that come with non-disk-array models of the PC Server 320 have one 8-bit (narrow) and one 16-bit (wide) internal cable connector, plus one 16-bit (68-pin) external connector.

In earlier non-disk-array models that come with a narrow hard disk drive, a narrow (8-bit) cable is provided. More recent non-disk-array models come with a wide (16-bit) cable. Earlier models of non-disk-array servers not equipped with a hard disk drive have a 4-drop narrow cable, with the CD-ROM drive attached to the last connector. More recent models come with a 7-drop, wide (16-bit) cable. If your server comes with a narrow cable, and you plan to install wide devices (16-bit), you must purchase a wide cable.

## SCSI Subsystem

The IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter that comes with disk-array models of the PC Server 320 has two 16-bit (wide) internal cable connectors, and one 16-bit (68-pin) external connector. Disk-array models all come with the Hot-Swap Bay option and have a 2-drop wide cable.

The SCSI standard defines the signals that are carried on the interface. In all SCSI configurations, the interface must be terminated at both ends of the cable. When both an internal cable and an external cable are present, the entire configuration is seen as one long bus. In this case, there are only two termination points, at the far ends of the internal and external cables.

The interface uses *daisy-chain cabling*, where each device except the last one (internal or external) has one cable going into it and another coming out of it in a single connector. The last device has an incoming cable and a *terminator*.

### Termination

SCSI devices are cabled to each other and to the SCSI adapter or SCSI controller. The device at each end of the interface must be terminated.

If you have only internal SCSI devices connected to one of the two internal connectors on the integrated SCSI controller, the controller becomes the termination at one end of the cable.

For disk-array models, termination is set automatically.

The following rules apply to SCSI-device termination:

*Note:* For specific information about termination, use the instructions supplied with the device.

- If you have both internal SCSI devices and external SCSI devices, the devices at the ends of the internal and external cables must be terminated. The adapter must not be terminated.
- If you have only one external device, that device must be terminated

*Note:* If you connect external devices, you can attach internal SCSI devices to only one of the internal SCSI connectors.

- If you have more than one internal SCSI device, the device farthest from the SCSI controller must be terminated. Other internal drives connected to the same SCSI controller must not be terminated.

## SCSI Subsystem

## Chapter 7. Disk-Array Subsystem

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IBM provides an integrated disk-array subsystem as a standard feature on some PC Server 320 models. Each disk-array model of PC Server 320 contains an IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter.

Disk-array models support up to six *hot-swappable* hard disk drives. You can remove and replace a hot-swappable drive while the server remains powered on. All other PC Server 320 models can be upgraded to provide the same hot-swap disk drive support.

### Internal Disk-Array Subsystem

When you connect several hard disks together and configure the hard disk controller to access them in a predetermined pattern, you create what is known as a *disk array*.

Disk arrays are used to improve security, performance, or reliability. They provide faster input and output rates than single large-capacity drives, because the files are stored on multiple individually addressable disks and can be found more quickly during I/O requests.

The amount of improvement in security, performance, and reliability depends on the application programs that are running and the type of disk array being used. The type of disk array depends on the data-storage patterns supported by your hard disk controller, operating system, and application programs.

Disk-array models of the PC Server 320 support the redundant array of independent disks (RAID).

### RAID Technology

RAID technology groups two or more hard disk drives in a server into an *array* that is defined as a single *logical drive*. This logical drive appears to the operating system as a single *physical drive*. RAID technology enhances capacity, access times, and data transfer rates beyond the physical limitations of existing hard disk drives.

## Disk-Array Subsystem

In addition, RAID technology can provide enhanced fault tolerance. If a physical drive fails in a RAID level 1 or level 5 disk array, the system continues to run, with no operator intervention required. You can replace the defective (*defunct*) drive without turning off the server (*hot-swap*) and the new drive contents are rebuilt from the information on the other drives. This rebuilding process takes place in the background with the system online. Once the drive contents are rebuilt, full performance and fault-tolerant functions are restored.

When you install internal SCSI drives in your server, you can connect them to either the Channel 1 or the Channel 2 connector on the RAID adapter (see the *User's Handbook* for more information). The *external* connector on the adapter also is designated "Channel 2." You cannot connect devices to both the internal Channel 2 and external Channel 2. This means that you can connect SCSI devices to both the internal channels and not the external channel; or, you can connect SCSI devices to one of the internal channels and the external channel, but not to all three channels simultaneously.

### Disk-Array Classifications

The term "RAID" is commonly qualified by a number that classifies the different types of data-storage patterns used by disk arrays. There are six basic RAID classifications: RAID-0 through RAID-5. Your server supports the RAID classifications RAID-0, RAID-1, and RAID-5.

### RAID Level 0

RAID level 0 stripes the data across all of the drives of the array and offers substantial speed enhancement, but provides no data redundancy. Therefore, a hard disk failure within the array results in loss of data in the logical drive assigned level 0, but *only in that logical drive*.

*Note:* Although in this case, logical drives assigned level 1 or 5 in the same array do not suffer loss of data, the status of these drives is *Critical*, and they cannot sustain another hard disk drive failure. They operate at reduced performance. Replace

and rebuild the defunct hard disk drive promptly to avoid a multiple hard disk drive failure.

When the defunct drive is replaced, all the logical drives assigned RAID levels 5 and 1 are rebuilt onto that hard disk drive; the level 0 logical drive is defined, but the data that was in the defunct level 0 logical drive is lost.

Even though the risk of data loss is present, you might want to consider assigning RAID level 0 to one of the logical drives so that you can take advantage of the speed offered with this level.

One way you might use this logical drive is to enter data that you back up each day and for which safety is not of primary importance; that is, you can re-create the data easily.

Another instance when you might want to use a level 0 logical drive is when the work you are doing requires maximum capacity—level 0 provides you the largest capacity of the three RAID levels offered, because no room is taken up for data parity storage.

### *Notes:*

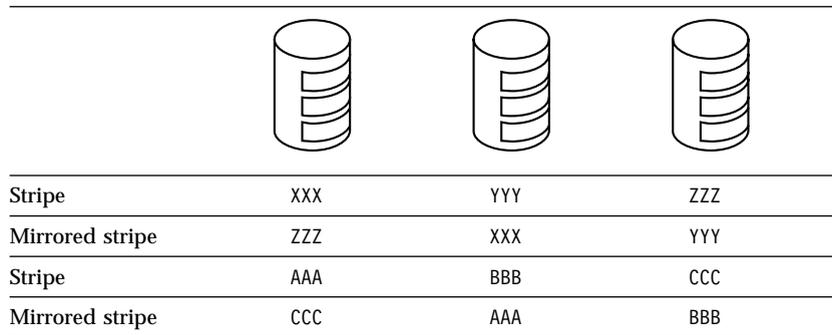
- A *hot-spare drive* will not be activated in the event of a drive failure in an array that contains a logical drive assigned RAID level 0. Refer to “Hot-Spare Drive Replacement” on page 64 for a description of hot-spare drives.
- All logical drives in an array containing only one drive are automatically assigned RAID level 0.

## RAID Level 1

RAID level 1 provides an enhanced feature for disk *mirroring* that stripes data and copies of the data across all the drives of the array. The first stripe is the data stripe; the second stripe is the *mirror* (copy) of the first data stripe, but written on another drive. Because the data is mirrored, the capacity of the logical drive when assigned level 1 is 50% of the physical capacity of the grouping of hard disk drives in the array. RAID level 1 uses two drives; if more than two drives are in the array, your RAID level is automatically switched to Enhanced RAID level 1.

## Disk-Array Subsystem

The following illustration shows data arranged in a disk array with three hard disk drives, with the logical drive assigned RAID level 1. Notice that the mirror of the first data stripe (in this case, XXX YYY ZZZ) is shifted one drive. The other data stripes in level 1 follow the same pattern.



If you have only two drives available the second drive is a mirror copy of the first drive.

### RAID Level 5

RAID level 5 stripes data and parity across all drives of the array. When a disk array is assigned level 5, the capacity of the logical drive is reduced by one drive (for data parity storage).

Level 5 is generally the most desirable choice, because it offers both data protection and increased capacity. Level 5 gives you higher capacity than level 1, but level 1 offers better performance.

#### Notes:

- If you want to have a hot-spare drive and also assign level 5, you must have at least four hard disk drives, with no logical drives assigned level 0. The hot-spare drive must be of the same capacity as the defunct drive.
- Before you reconfigure or redefine an existing array, be sure to back up your data. When you redefine an existing array, all of the data in that array is lost.

## Hard Disk Drive Capacities

With a server, it is important to understand the implications of hard disk drive capacities and how they influence the way you create disk arrays.

Although the drives in the disk array can be of different capacities (for example 1 GB or 2 GB), they are treated in the disk array configuration as if they all have the capacity of the smallest disk drive. Therefore, if you have four drives of 1 GB, 1 GB, 1 GB, and 2 GB grouped in one disk array, the total capacity of the array will be 4 GB (instead of the 5 GB physically available).

*Note:* The total capacity of the example array is 4 GB; a RAID Level 5 array that consists of the same drives has a usable capacity of 3 GB.

By the same logic, if you add a smaller drive to a group of drives, such as a 1 GB drive to a system containing three 2 GB drives, the total capacity of an array that includes all four drives will be 4 GB, instead of the 7 GB that are physically available.

## Disk-Array Subsystem

### *Hard Disk Drive Mapping*

The drive locations shown on your RAID Configuration utility screen (described by channel and bay number) are shown mapped to the actual physical locations in your server in the following tables. The SCSI ID for each device is also shown in reference to the channel and bay to which it is attached. Table 1 illustrates the server configuration as it is shipped, with Channel 2 not connected.

Displayed Channel Number	Displayed Bay Number	Bay Location	SCSI ID
1	1	1	0
1	2	2	1
1	3	3	2
1	4	4	3
1	5	5	4
1	6	6	5
1	7	7 (CD-ROM)	6

*Table 1. One Channel Mapping*

Table 2 shows an example of using one internal and one external channel on the RAID adapter. The second channel is attached to an external DASD storage enclosure. Refer to the documentation that comes with the storage enclosure for physical locations.

Displayed Channel Number	Displayed Bay Number	Bay Location	SCSI ID
1	1	1	0
1	2	2	1
1	3	3	2
1	4	4	3
1	5	5	4
1	6	6	5
1	7	7 (CD-ROM)	6
2	1	External	0
2	2	External	1
2	3	External	2
2	4	External	3
2	5	External	4
2	6	External	5
2	7	External	6

*Table 2. One Internal and One External Channel Mapping*

### Additional Storage Capacity

When you add one or more hard disk drives to your server, you must configure a new disk array before you can use the added storage capacity. You can either reconfigure the existing disk array to include the capacity offered with the added drive or drives, or group the added drives into their own array. You also can create an array with only one drive.

*Note:* Before you reconfigure or redefine an existing array, be sure to back up your data. When you redefine an existing array, all of the data in that array is lost.

### Logical Drives

It is helpful to understand how the system manages logical drives and how many you can define.

When you create an array, you are combining several hard disk drives into one storage area. The array then can be used as a single logical drive or can be subdivided into several logical drives. A logical drive of a disk array can be any size you choose within the size limitations of the array. The RAID adapter supports up to four independent arrays and a total of eight logical drives. Each array can be formed from a maximum of eight drives. An array can span both channels.

For example, if you have only one array, it can be either a single logical drive or divided into as many as eight. If you have two or more arrays, you can have each one as one logical drive (a total of four), or you can divide them into multiple logical drives, as long as the total number of logical drives for the arrays is no more than eight.

The operating system considers each of these logical drives just as it does a physical hard disk drive. That is, the logical drives can be partitioned by the FDISK program (or its equivalent) in the same way that the operating system partitions a hard disk drive.

If you install an operating system, you either can allow the installation program to determine how the FDISK program (or its equivalent) allots the space within a logical drive, or manipulate the

## Disk-Array Subsystem

FDISK program yourself to partition the available space. The documentation that you received with your operating system explains how it handles *mapping*.

### Improved System Performance

When hard disk drives are united into a single logical drive, data can be transferred in parallel from the multiple drives in the array. This parallel transfer yields data-transfer rates that are many times higher than with non-arrayed drives. This increased speed makes the server better able to meet the *throughput* (the amount of work in a given amount of time) or productivity needs of the multiple-user network environment.

The ability to respond to multiple data requests provides not only an impressive increase in throughput, but also a decrease in response time. The combination of parallel transfers and simultaneous responses to multiple requests allows disk arrays to provide the highest level of performance in network environments.

### Disk Array Adapter Features

The IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter supports:

- A 32-bit PCI data bus (automatically configurable)
- Data transfer rates up to 40MB per second
- 4 MB adapter cache, which significantly improves server performance by keeping frequently used SCSI-device data available for immediate transfer
- SCSI-2 Tagged Command Queuing
- RAID levels 0, 1, and 5
- *Hot-spare drive*, which enables the disk-array subsystem to automatically perform data recovery and data reconstruction in the event of a single disk failure
- Two internal 16-bit data-bus interfaces, which can support four arrays

With RAID technology, data is *striped* across an array of hard disk drives. *Striping* is the process of storing data across all the disk drives that are grouped in an array. This data-distribution scheme complements the way the operating system requests data.

### Overlapped Input/Output Operation

Because the RAID Adapter provides multiple data paths to and from arrayed drives, your server can respond to requests from several users simultaneously. With its overlapped input and output operation, if one user requests data that resides on the first drive of the array, and a second user requests data that resides on the second drive, the adapter can simultaneously deliver both pieces of information.

### Interleave Depth/Stripe Unit

The granularity at which data from one file is stored on one drive of the array before subsequent data is stored on the next drive of the array is called the *interleave depth*. The interleave depth can be set for optimum system performance to a stripe unit size from 8 KB to 64 KB of data.

The collection, in logical order of these stripe units, from the first drive of the array to the last drive of the array, is called a *stripe*.

### Queue Depth

Commands are queued in the adapter with a queue depth of 61. To obtain better performance, the commands in the queue will be *reordered* and *coalesced* on a hard disk drive basis. That is, the adapter organizes the commands according to which drive will be responding, and then orders and combines two or more commands, when possible, before sending them to the drives.

### Cache

The RAID Adapter has 4 MB of memory, of which more than 3 MB is used as a data cache. This cache can be configured to operate in a write-through or write-back mode on a logical drive basis. The cache memory has parity to detect memory errors and uses retry algorithms to recover from sporadic errors.

### Hot-Spare Drive Replacement

A *hot-spare drive* is a hard disk drive in your server that is defined for automatic use in the event of a drive failure. The hot-spare drive must have the same capacity as the drives in the array it is intended to replace. You can define as many hot-spare drives as you want.

If a drive fails, the system automatically switches to the hot-spare drive, and the data from the defunct drive is automatically recreated in the hot-spare drive. When the defunct drive is replaced using the operating-system-specific utility program, the system automatically defines the replacement drive as a hot-spare drive.

### Data Protection

The RAID Adapter provides the server with a data redundancy technique that distributes data across all the drives in the array. If a drive fails, read and write requests are serviced by the remaining drives in the array, without loss of data. The defunct hard disk drive *appears* to be operating correctly, although at reduced performance, despite its total failure.

When you replace the defunct drive, the data in logical drives that are assigned levels 1 and 5 is rebuilt on the new hard disk drive using the parity information stored on the other hard disk drives of the array. It is important that the defunct drive be replaced and rebuilt in a timely manner so that you avoid multiple-drive failures and reduced performance. Once the drive contents are rebuilt, full performance and fault-tolerant functions are restored.

## Chapter 8. Configuration

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You play a key role in how your server allocates resources to hardware devices and software programs. This resource-allocation process is referred to as *configuration*. The steps required to configure your server depend on the PC Server 320 model you have, the number and variety of devices that you install, and the software programs that you install.

Your server has the flexibility and power to support several types of adapters and devices. Depending upon your model, this flexibility lets you choose from among thousands of adapters and devices that comply with the following standards:

- Peripheral component interconnect (PCI)
- Micro Channel architecture
- Enhanced industry standard architecture (EISA)
- Industry standard architecture (ISA)
- Small computer system interface (SCSI)

In general, the greater the number and variety of hardware devices and software programs that you install, the more you will have to interact with your server and your devices to correctly configure your system.

# Configuration Programs

All PC Server 320 models come with menu-driven configuration programs. These programs enable you to view or change:

- System-board settings and assignments
- EISA and ISA device assignments
- Micro Channel device assignments
- Disk array configuration assignments
- SCSI device assignments

The types of configuration programs provided with your server depend on the model you have purchased. All PC Server 320 models come with built-in setup and configuration utility programs, which you can access during system startup. These programs are stored in nonvolatile random access memory (NVRAM) on the system board.

The built-in setup and configuration programs enable you to view or change system-board settings, such as interrupt request levels (IRQs), memory-address assignments, I/O port assignments, and the startup sequence for non-disk-array drives. These programs also allow you to set the date and time, set passwords, and define system security.

Step-by-step instructions for using all of the setup, configuration, and utility programs are provided in your *User's Handbook*.

In most cases, the server will operate using the default settings. Before you install a new device or program, or make changes to your system-board settings, be sure to start the built-in utility programs; then record the current setting. In the unlikely event that a conflict occurs, you will be able to change the settings back to their original values.

### Configuration Programs for PCI/EISA Models

In addition to the built-in setup and configuration utility programs, PCI/EISA models come with two of the following configuration programs and diskettes:

- EISA Configuration Diskette

This diskette comes with all PCI/EISA models. It contains configuration and utility programs for EISA and ISA adapters. You can use the programs on this diskette to configure EISA and ISA adapters. (Instructions for using this diskette are in your *User's Handbook*.)

- RAID Configuration Option Diskette

This diskette comes with disk-array models. It contains device drivers, monitoring programs, and menu-driven configuration programs that enable you to define, create, modify, or delete your disk arrays. The programs on this diskette also enable you to view or change the SCSI device assignments for the drives attached to the IBM RAID adapter.

See your *User's Handbook* for additional information about defining or changing your disk-array configuration.

- SCSISelect utility program

This built-in SCSI-2 program comes with non-disk-array models. It enables you to view or change the assignments of your SCSI devices. You can use this utility program to change default settings, resolve configuration conflicts, or perform a low-level format on a SCSI hard disk drive. See “The SCSISelect Utility Program” on page 69 for more information. (Instructions for using this program are in your *User's Handbook*.)

### Configuration Programs for PCI/Micro Channel Models

In addition to the built-in setup and configuration utility programs, PCI/Micro Channel models come with the following configuration programs and diskettes:

- PC Server 320 Reference Diskette

This diskette comes with all PCI/Micro Channel models. It contains configuration, utility, and test programs for Micro Channel adapters. You can use the programs on this diskette to automatically configure, view, or change the settings of Micro Channel adapters.

This diskette also contains the Copy an Option Diskette program, which enables you to copy option-specific configuration programs from Option Diskettes to your backup copy of the Reference Diskette. (When you install additional Micro Channel adapters, you must use the Copy an Option Diskette program to update your backup copy of the Reference Diskette.) Instructions for using the programs on the Reference Diskette are in your *User's Handbook*.

- RAID Configuration Option Diskette

This diskette comes with disk-array models. It contains device drivers, monitoring programs, and menu-driven configuration programs that enable you to define, create, modify, or delete your disk-arrays. The programs on this diskette also enable you to view or change the SCSI device assignments for the drives attached to the IBM RAID adapter.

*Note:* The SCSI termination and SCSI IDs for hot-swap drives are automatically set by the backplane in the hot-swap bay option.

See your *User's Handbook* for additional information about defining or changing your disk-array configuration.

- SCISSelect utility program

This built-in SCSI-2 utility program enables you to view or change the assignments of SCSI devices that are connected to the integrated SCSI-2 controller. You can use this utility program to change default settings, resolve configuration conflicts, or perform a low-level format on a SCSI hard disk drive that is connected to the integrated SCSI-2 controller. See “The SCISSelect Utility Program” for more information. (Instructions for using this program are in your *User's Handbook*.)

### The SCISSelect Utility Program

The integrated SCSI-2 controller (on PCI/Micro Channel models) and the SCSI-2 adapter (in non-disk-array PCI/EISA models) each have a built-in, menu-driven configuration program that enables you to view or change SCSI settings. You can use the SCISSelect program to change default settings, locate and correct configuration conflicts, and format a new SCSI hard disk.

The settings that you can view or change include:

- Host Adapter SCSI ID  
Select this choice to change the SCSI ID of the SCSI-2 controller or adapter from its default value of 7.
- SCSI Parity Checking  
Select this choice to enable or disable parity checking on the SCSI-2 adapter or controller. The default setting is *Enabled*.
- Host Adapter SCSI Termination  
Select this choice to change the SCSI-2 adapter or controller termination. The default setting is *Low On / High On*.
- SCSI Device Configuration  
Select this choice to configure SCSI device parameters. Before you can make updates, you must know the ID of the device whose parameters you want to configure.

## Configuration

- Advanced Configuration Options

Select this choice to view or change the settings for advanced configuration options. Change these values only if necessary.

These options include:

- Startable CD-ROM drive: When set to *On*, you can include the CD-ROM drive as a startup device. For this option to take effect, you must insert a startable CD in the CD-ROM drive.
- Init13Extensions: When set to *On*, these BIOS extensions are enabled.

## Configuration Process Overview

When you install a new device or change the position of an existing device, you might need to reconfigure your server. The steps required to configure your server depend on the option you install.

### Configuring a PCI/EISA Model

The PCI/EISA models use jumpers, switches, and configuration programs to assign interrupt levels, input/output addresses, memory addresses, and other server resources.

Some options, such as memory and PCI adapters, are recognized and configured automatically by the system. However, other options, such as EISA adapters and SCSI devices, must be manually configured.

## Configuration

### *Configuring EISA Adapters*

Before you install an EISA or ISA adapter in your server, be sure to check the documentation that comes with the adapter. Some adapters have jumpers or switches that you must set to assign system resources, such as interrupt levels and memory addresses. Before you assign a system resource to the adapter, you must verify that the resource is not already assigned to the system board or another device. To do this:

1. Check the adapter's documentation to see which system resources, such as interrupt level or memory-address space, it needs to function properly.
2. Start the built-in setup and configuration programs.
3. Record the settings of the existing devices.
4. Compare the settings of the existing devices to the settings required by the new adapter; then choose settings for the new adapter that will not conflict with an existing device.

Some adapter documentation might list only one choice for a system resource. For example, the adapter might operate only at interrupt level 3. If this occurs, you might need to change the assignment of an existing device to avoid a configuration conflict.

5. Set the jumpers or switches on the new adapter.
6. Install the new adapter in an available expansion slot.
7. Use the EISA Configuration Diskette to assign or verify the adapter's configuration.

### **Configuring a PCI/Micro Channel Model**

The PCI/Micro Channel models use programmable configuration features, configuration programs, and configuration files to assign interrupt levels, input/output addresses, memory addresses, arbitration levels, and other server resources.

Some options, such as memory, are recognized and configured automatically by the system. However, other options, such as SCSI devices, must be manually configured.

### *Programmable Configuration*

The programmable configuration hardware consists of:

- Nonvolatile RAM on the system board
- Hardware used to store the device ID
- Registers on the system board and adapters

Instead of jumpers and switches that you set manually, the system board and adapters have registers that act as electronic switches. These read and write registers are set by the POST routine each time you turn on the server. The registers are volatile storage areas, and retain the configuration information only while the server is turned on. When you turn off the server, the configuration information is cleared from these registers.

A current copy of the configuration information is stored in a battery-backed memory area known as nonvolatile RAM. The same battery that supports the nonvolatile RAM module supports the real-time clock module, which provides a time-of-day clock, a 100-year calendar, and 64 bytes of nonvolatile RAM that the server uses to store some setup information, such as the power-on password.

Each adapter has a unique device ID. The POST routine and the configuration programs use the device ID to identify the type and location of each adapter in the server. The configuration programs also use the device ID during the configuration process to locate the appropriate configuration files for the system board and Micro Channel adapters.

## Configuration

The programmable configuration hardware, together with the configuration programs and configuration files, simplifies the process of configuring the server hardware by:

- Eliminating the need for setting jumpers and switches on the system board and adapters
- Enabling you to configure the server automatically or manually using menu-driven programs
- Identifying the type and location of each device in the server
- Resolving server resource conflicts

**Configuration Files:** The Set/View Micro Channel Configuration program on the Reference Diskette uses configuration files to assign interrupt levels, I/O addresses, memory addresses, arbitration levels, and other server resources.

When you install an optional device, such as a network adapter, you might need to copy configuration files from the Option Diskette that comes with the device to the Reference Diskette.

The Set/View Micro Channel Configuration program uses two types of files to configure the server: adapter description files and adapter description programs. Some devices require only an adapter description file, but more complex devices sometimes require an adapter description program. Configuration files for optional devices usually are provided on an Option Diskette supplied with the device.

The following table shows the types of files used to configure the server. You can identify each file by the first digit in the file name and by its file-name extension. The *xxxx* in the file name represents the ID for the device.

File Name	Description
@xxxx.ADF	Adapter description file
Cxxxx.ADF	Adapter description program
Dxxxx.ADF	Adapter description file (system board)
Pxxxx.ADF	Adapter description file (built-in features)
Sxxxx.ADF	Adapter description program (system board)

*Table 3. Identifying Configuration Files*

***Adapter Description Files:*** The Set/View Micro Channel Configuration program uses the information in an adapter description file to identify the device and to allocate server resources.

Adapter description files list the device ID and several choices for:

- Interrupt levels
- I/O, RAM, and read only memory (ROM) addresses
- Arbitration levels
- Other server resources that the device can use

Usually, these files also contain the informational text messages and interactive prompts that you use when you configure the server.

During the configuration process, the Set/View Micro Channel Configuration program locates and reads the adapter description file for each device. If the program cannot find the adapter description file, the server prompts you to insert the Option Diskette for the device. If you insert the diskette, and the Set/View Micro Channel Configuration program still cannot find the adapter description file, the program disables the device.

The adapter description file for a device specifies the type of memory (system or nonsystem) that the device requires. System memory is controlled by the primary operating system, and only masters, such as bus masters, can use it. Nonsystem memory is not controlled by the operating system. When nonsystem memory is physically located on an adapter, it is known as memory-mapped I/O.

***Adapter Description Programs:*** Some devices have a memory-address space that is not accessible before the operating system starts. These devices need an adapter description program to configure them during the configuration process.

A device that needs an adapter description program has an entry in its adapter description file that tells the Set/View Micro Channel Configuration program to run the adapter description program. During configuration, the Set/View Micro Channel Configuration

## Configuration

program reads the adapter description file for each device and runs an adapter description program, if instructed.

If the Set/View Micro Channel Configuration program cannot find the adapter description program, the server prompts you to insert the Option Diskette for the device. If you insert the diskette, and the Set/View Micro Channel Configuration program still cannot find the appropriate adapter description program, the program disables the device.

*Option Configuration Files:* The configuration files for an optional device normally are provided on an Option Diskette that comes with the device. This diskette contains files that the system uses to assign settings that define how the device will operate.

Whenever you install a device that comes with an Option Diskette, be sure to read the instructions that come with the device. You might need to copy configuration files from the Option Diskette to the backup copy of the Reference Diskette. Use the instructions provided with the device to install the configuration files. If no instructions are provided, use the Copy an Option Diskette program to install the configuration files.

Before copying the configuration files, the Copy an Option Diskette program checks the Option Diskette for valid configuration files. If the program does not find valid configuration files, a message appears. If the program finds valid configuration files, it checks the Reference Diskette for duplicate file names. If it finds duplicate file names, it checks the dates of the files; then it copies only the files from the Option Diskette that have later dates than the existing files. When option-configuration files are copied to the Reference Diskette, they become an integrated part of the system programs.

## Configuration Conflicts

The resources used by your server consist of interrupt request levels (IRQs), direct memory access (DMA) channels, I/O ports (for example, serial and parallel), and memory. This information is useful when a resource configuration conflict occurs.

Conflicts in the configuration occur if:

- A device is installed that requires the same resource as another device. (For example, a conflict occurs when two adapters try to write to the same address space.)
- A device resource is changed (for example, changing jumper settings).
- A device function is changed (for example, assigning *COM 1* to two different serial ports).
- A software program is installed that requires the same resource as a hardware device (for example, an expanded memory specification (EMS) device driver that uses the address required by the SVGA video adapter).

The steps required to resolve a configuration error are determined by the PC Server 320 model you have, the number and variety of devices that you install, and the software programs that you install. Refer to your *PC Server 320 User's Handbook* for more information.

## Configuration

## Chapter 9. Input/Output Ports

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The input/output (I/O) connectors (ports) on the back of your server are for attaching external devices, such as printers, keyboards, and monitors to your server. The I/O connectors include:

- Two serial ports
- One parallel port
- One video port
- One keyboard
- One auxiliary-device (mouse) port
- One wide (16-bit) SCSI port

### Serial Ports

Your server provides two serial ports. Serial ports are used to communicate with printers, plotters, external modems, auxiliary terminals, and other computers.

Serial ports can transfer data *asynchronously*; they can transmit any number of bits at any time, with no restriction on the duration of the pauses between characters.

### Serial Port Connectors

Each serial port uses a 9-pin, male D-shell connector on the back of the server. The pin-number assignments of this connector conform to the RS-232C industry standard. Table 4 shows the pin-number assignments for the serial port connector.

Pin	Signal	Pin	Signal
1	Data carrier detect	6	Data set ready
2	Receive data	7	Request to send
3	Transmit data	8	Clear to send
4	Data terminal ready	9	Ring indicator
5	Signal ground		

*Table 4. Serial Port Connector Pin-number Assignments*

### Serial Port Numbering

When you turn on your server, the power-on self-test (POST) routine assigns the serial ports to specific communication port addresses: COM1 and COM2. You can install adapters to support up to 16 serial ports in your server, named COM1 through COM16.

Some application programs use only COM1 and COM2, and some modems are designed to be selected only at certain communication port addresses. In some configurations, you might need to change communication port address assignments to resolve conflicts. To do this, use the built-in setup and configuration utility programs.

*Note:* If you experience a problem with a non-IBM device when attaching it to the serial port, you might need to set the serial port direct memory access (DMA) arbitration level to "Disabled." See the "Configuring Your Server" section in the *User's Handbook* for more information about address assignments.

## Parallel Port

Your server provides one 25-pin parallel port. Parallel ports are used to communicate with printers and other devices, such as some CD-ROM and tape drives.

### Parallel Port Connector

The parallel port uses a 25-pin, female D-shell connector on the back of the servers. (The parallel port conforms to the Institute of Electrical and Electronics Engineers (IEEE) Standard 1284. Table 5 shows the pin-number assignments for the parallel port connector.

Pin	Signal	Pin	Signal
1	STROBE	14	-AUTO FD XT
2	Data 0	15	-ERROR
3	Data 1	16	-INIT
4	Data 2	17	-SLCT IN
5	Data 3	18	Ground
6	Data 4	19	Ground
7	Data 5	20	Ground
8	Data 6	21	Ground
9	Data 7	22	Ground
10	-ACK	23	Ground
11	BUSY	24	Ground
12	PE	25	Ground
13	SLCT		

*Table 5. Parallel Port Connector Pin-number Assignments*

## Input/Output Ports

### Video Port

The video port allows you to attach a video monitor to your server. Your server provides a 15-pin video port connector. In PCI/Micro Channel models, the video port connector is located on the system board. In PCI/EISA models, the video port connector is on an adapter.

The following table shows the pin-number assignments for the video port connector.

Pin	Signal
1	Red
2	Green or monochrome
3	Blue
4	Monitor ID 2 (not connected)
5	Ground
6	Red ground
7	Green ground or monochrome ground
8	Blue ground
9	Reserved
10	Ground
11	Monitor ID 0 (not connected)
12	Monitor ID 1 (not connected)
13	Horizontal synchronization (Hsync)
14	Vertical synchronization (Vsync)
15	Monitor ID 3 (not connected)

*Table 6. Video Port Connector Pin-number Assignments*

### Keyboard and Auxiliary-Device Ports

Your server provides one keyboard port and one auxiliary-device port. An auxiliary device can be a mouse or other pointing device.

Table 7 on page 83 shows the pin-number assignments for the keyboard and auxiliary-device port connectors.

Pin	Signal
1	Data
2	Not connected
3	Ground
4	+5 V dc
5	Clock
6	Not connected

Table 7. Keyboard and Auxiliary-Device Port Connector Pin-number Assignment

## SCSI Ports

The PCI/Micro Channel system board has an integrated SCSI-2 Fast/Wide controller. Disk-array and non-disk-array PCI/Micro Channel models come with the controller. This integrated controller supports up to 15 devices, and provides the following ports:

- One 8-bit internal connector
- One 16-bit internal connector
- One 16-bit external connector

You can attach SCSI devices to only two of these connectors simultaneously.

All disk-array models come with an IBM SCSI-2 Fast/Wide PCI-Bus RAID Adapter preinstalled. The PCI/Micro Channel disk-array models come with both this RAID adapter and the SCSI-2 Fast/Wide controller. The PCI/EISA disk-array models come with only this RAID adapter. The RAID adapter supports up to 14 SCSI devices and provides three additional SCSI-2 connectors:

- Two 16-bit internal connectors
- One 16-bit external connector

You can attach SCSI devices to only two connectors simultaneously.

The non-disk-array PCI/EISA models come with an IBM SCSI-2 Fast/Wide PCI Adapter. It supports up to 15 devices, and provides the following ports:

- One 8-bit internal connector
- One 16-bit internal connector
- One 16-bit external connector

## Input/Output Ports

Table 8 shows the pin-number assignments for the 2-by-34-pin SCSI port connector.

Pin	Signal	Pin	Signal
1	Ground	35	Data 12
2	Ground	36	Data 13
3	Ground	37	Data 14
4	Ground	38	Data 15
5	Ground	39	Data P1
6	Ground	40	Data 0
7	Ground	41	Data 1
8	Ground	42	Data 2
9	Ground	43	Data 3
10	Ground	44	Data 4
11	Ground	45	Data 5
12	Ground	46	Data 6
13	Ground	47	Data 7
14	Ground	48	Data P0
15	Ground	49	Ground
16	Ground	50	Ground
17	+Term power	51	+Term power
18	+Term power	52	+Term power
19	Reserved	53	Reserved
20	Ground	54	Ground
21	Ground	55	-Attention
22	Ground	56	Ground
23	Ground	57	-Busy
24	Ground	58	-Acknowledge
25	Ground	59	-Reset
26	Ground	60	-Message
27	Ground	61	-Select
28	Ground	62	-Control/Data
29	Ground	63	-Request
30	Ground	64	-Input/Output
31	Ground	65	Data 8
32	Ground	66	Data 9
33	Ground	67	Data 10
34	Ground	68	Data 11

*Table 8. 2-by-34-Pin SCSI Port Pin-Number Assignments*

Table 9 shows the pin-number assignments for the 2-by-25-pin narrow SCSI-2 connector.

Pin	Signal	Pin	Signal
1	Ground	26	Terminator power
2	Data 0	27	Reserved
3	Ground	28	Reserved
4	Data 1	29	Ground
5	Ground	30	Ground
6	Data 2	31	Ground
7	Ground	32	-Attention
8	Data 3	33	Ground
9	Ground	34	Ground
10	Data 4	35	Ground
11	Ground	36	-Busy
12	Data 5	37	Ground
13	Ground	38	-Acknowledge
14	Data 6	39	Ground
15	Ground	40	-Reset
16	Data 7	41	Ground
17	Ground	42	-Message
18	Data P	43	Ground
19	Ground	44	-Select
20	Ground	45	Ground
21	Ground	46	-Control/data
22	Ground	47	Ground
23	Reserved	48	-Request
24	Reserved	49	Ground
25	Not connected	50	-Input/output

Table 9. The 2-by-25-Pin (Narrow) SCSI Port Connector Pin-number Assignment

## Input/Output Ports

## Chapter 10. Video Subsystem

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Your PC Server 320 provides super video graphics array (SVGA) capability. PCI/Micro Channel models contain a video controller on the system board. PCI/EISA models contains a video adapter. Both the controller and the adapter use an external 15-pin analog video connector. This connector enables you to attach a video monitor to your server. For information about this connector, see “Video Port” on page 82.

The PC Server 320 supports high-resolution graphics and fast refresh rates that exceed the specifications of the International Organization for Standardization (ISO) 9241 Part 3, Visual Display Requirements. It also provides reduced-flicker operation when used with noninterlaced monitors that meet ISO standards. For more information about noninterlaced monitors, see “Vertical-Refresh Rate” on page 89.

The video subsystem includes a video monitor buffer that contains one MB of *video dynamic random access memory (VDRAM)*. The amount of VDRAM in your server and the capabilities of the video driver determine the resolution and the number of colors that are supported.

All PC Server 320 models support the following screen resolutions and numbers of colors:

- 640 x 480 pels with up to 16.8 million colors (noninterlaced)
- 800 x 600 pels with up to 65 536 colors (noninterlaced)
- 1024 x 768 pels with up to 256 colors (noninterlaced)
- 1280 x 1024 pels with up to 16 colors (interlaced)

*Note:* Monitors supporting 1280 x 1024 pels and up to 16 colors require operating system support. See your operating system documentation for more information.

Additional features of the video subsystem include:

- Integrated VGA emulation
- Support for the 132-column text mode
- Reduced-flicker operation for noninterlaced monitors that meet ISO standards

## Video Subsystem

You can install a video adapter in one of the expansion slots. The system BIOS detects the installed adapter automatically at system start-up.

Monitors come in many sizes and types. The video controller supports a wide range of monochrome and color monitors having various capabilities.



There are many types of monitors, the most common distinguishing characteristics of monitors are *resolution*, *dot pitch*, *vertical-refresh rates*, screen size, and color.

### Resolution and Dot Pitch

If you look closely at the screen, you can see that the entire image is made up of many tiny dots. These dots are called *pels*. Resolution is measured by the number of pels needed to fill the screen (horizontal-by-vertical).

Dot pitch is more difficult to visualize. The inside of the monitor screen is coated with light-emitting materials called *phosphors*. Color monitors use three phosphors: red, green, and blue. The phosphor coating is made up of dots arranged in a red-green-blue pattern. The distance from the center of one phosphor dot to the center of the next phosphor dot of the same color is called the *dot pitch*. Dot pitch is measured in millimeters, such as 0.28, 0.31, and 0.41.

In general, the monitor with the highest resolution and finest dot pitch produces the sharpest image. A monitor with a fine dot pitch,

such as 0.28, produces sharper, better defined characters than a similar monitor that uses a coarser dot pitch, such as 0.41.

These characteristics can be very important. A system used extensively for detailed graphics might need a monitor that shows more colors, at a higher resolution and finer dot pitch, than one used exclusively for word processing. For some applications, a black-and-white (monochrome) monitor may work as well as a color monitor.

### Vertical-Refresh Rate

The phosphors on the inside of the monitor screen hold their brightness and color for a very short time. The image must be redrawn many times each second to refresh the phosphors. The vertical-refresh rate is the speed at which the image on the screen is redrawn.

The image is redrawn from top to bottom. By the time the bottom rows are drawn, the top rows are starting to fade. There are two ways of redrawing the image; *interlaced* and *noninterlaced*. The interlaced method draws every other row from top to bottom, then starts at the top to fill in the rows that were skipped on the first pass. The noninterlaced method draws the complete image on each pass.

The vertical-refresh rate affects the stability of the image on the screen. Monitors that have a fast, noninterlaced refresh rate, such as the IBM 952x monitors, provide a very stable image with little or no detectable flicker. Monitors with slower refresh rates tend to have more noticeable flicker. This is particularly noticeable with white and other light-colored backgrounds. You can often minimize flicker by changing the colors you work with. Many programs allow you to select colors.

Sensitivity to flicker varies from person to person; young people are the most sensitive. Noninterlaced flicker occurs when the screen is redrawn at a rate that is slow enough to be detected by the human eye. Interlaced flicker occurs when the pattern of pels in adjoining

## Video Subsystem

lines is very different, or when an object on the screen is made up of alternating bright and dim lines.

Some application programs cannot reproduce all colors, and use a technique called *dithering* to combine two colors. For example, light red might be produced by alternating lines of white and red. As the image is continually refreshed using the interlaced method, the red lines are drawn on one pass and the white lines on the next pass. As a result, the light-red object might appear to flicker while the rest of the image on the screen remains stable.

## Selecting a Monitor

A monitor having a fast noninterlaced refresh rate fully uses the video capabilities of your server. The IBM G50 or P50 are examples of monitors that use your server's video capabilities fully.

However, as mentioned earlier, some applications demand less video support than others. IBM provides many monitors that you can use with your system. The following is a partial list of monitors and their characteristics.

Type	Dot Pitch	Resolution	Maximum Vertical Refresh Rate
G40	0.28	1024x768	43 Hz interlaced
		800x600	60 Hz noninterlaced
		640x480	75 Hz noninterlaced
G50	0.28	1024x768	72 Hz noninterlaced
		800x600	85 Hz interlaced
		640x480	85 Hz noninterlaced
P50	0.26	1024x768	85 Hz noninterlaced
		800x600	85 Hz noninterlaced
		640x480	85 Hz noninterlaced

*Table 10. Monitor Types and Characteristics*

For more details, refer to the information that comes with your monitor.

See your IBM reseller or marketing representative for the current list of IBM monitors.

## Screen-Saver Programs

Leaving the monitor turned on for prolonged periods without changing what appears on the screen can adversely affect the monitor. Depending on what is on the screen, the image might burn into the phosphor coating (leaving a permanent image) or cause darkening of some areas of the screen.

You can avoid this problem by using a *screen-saver program*. A screen-saver program turns off the video signal when the keyboard or mouse has not been used for a defined period. This action results in a darkened blank screen. To resume working with the monitor, you press a predefined key to restore the previous image to the screen. Several companies produce screen-saver programs. Contact your IBM reseller or marketing representative for details.

## Brightness and Contrast Controls

The Brightness and Contrast controls are used to adjust the image on the screen for maximum viewing comfort. On a new monitor, set the controls near their center position. Setting these controls to their maximum position can decrease the useful life of a monitor.

As the monitor gets older, the image tends to become dimmer. Adjust the Brightness and Contrast controls to compensate for this condition.

## Arranging Your Workspace

To get the most from your computer, arrange both the equipment you use and your work area to suit your needs and the kind of work you do. Your comfort is of foremost importance, but light sources, air circulation, and the location of electrical outlets also can affect the way you arrange your workspace.

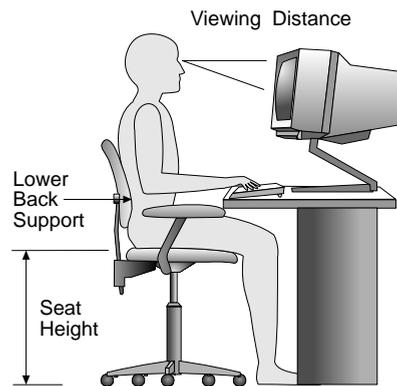
### Comfort

Although no single working position is ideal for everyone, here are a few guidelines to help you find a position that suits you best.

## Video Subsystem

Sitting in the same position for a long time causes fatigue. A good chair can make a big difference. The backrest and seat should adjust independently and provide good support. The seat should have a curved front to relieve pressure on the thighs. Adjust the seat so that your thighs are parallel to the floor and your feet are either flat on the floor or on a footrest.

When using the keyboard, keep your forearms parallel to the floor and your wrists in a neutral, comfortable position. Try to keep a light touch on the keyboard and your hands and fingers relaxed. You can change the angle of the keyboard for maximum comfort by adjusting the position of the keyboard feet.



Adjust the monitor so the top of the screen is at, or slightly below, eye level. Place the monitor at a comfortable viewing distance, usually 51 to 61 cm (20 to 24 in.), and position it so you can view it without having to twist your body. Also position other equipment you use regularly, such as the telephone or a mouse, within easy reach.

## Glare and Lighting

Position the monitor to minimize glare and reflections from overhead lights, windows, and other light sources. Even reflected light from shiny surfaces can cause annoying reflections on your monitor screen. Place the monitor at right angles to windows and other light sources, when possible. Reduce overhead lighting, if necessary, by turning off lights or using lower wattage bulbs. If you

install the monitor near a window, use curtains or blinds to block the sunlight. You might have to adjust the Brightness and Contrast controls on the monitor as the room lighting changes throughout the day.

Where it is impossible to avoid reflections or to adjust the lighting, an antiglare filter placed over the screen might be helpful. However, these filters might affect the clarity of the image on the screen; try them only after you have exhausted other methods of reducing glare.

Dust buildup compounds problems associated with glare. Remember to clean your monitor screen periodically using a soft cloth moistened with a nonabrasive liquid glass cleaner.

### Air Circulation

Your computer and monitor produce heat. The computer has a fan that pulls in fresh air and forces out hot air. The monitor lets hot air escape through vents. Blocking the air vents can cause overheating, which might result in a malfunction or damage. Place the computer and monitor so that nothing blocks the air vents; usually, 51 mm (2 in.) of air space is sufficient. Also, make sure the vented air is not blowing on someone else.

### Electrical Outlets and Cable Lengths

The location of electrical outlets and the length of power cords and cables that connect to the monitor, printer, and other devices might determine the final placement of your computer.

## Video Subsystem

When arranging your workspace:

- Avoid the use of extension cords. When possible, plug the computer power cord directly into an electrical outlet.
- Keep power cords and cables neatly routed away from walkways and other areas where they might get kicked accidentally.

For more information about power cords, see “Power Cords” on page 115.

## Chapter 11. Security Features

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Security features deter unauthorized use of your system and data. If you use your server in a public environment, such as an office, you can implement the security features of your server to protect it and the data stored on it.

Before implementing any security features, evaluate your security requirements. Where will the system be located? Should it be secured to permanent furniture or fixtures? Should use of the system be limited? After you have identified your security needs, you can activate or implement the appropriate security features.

Keylocks and a system of passwords help deter problems caused by unauthorized use. Other features are operating-system dependent, which means if you want to use them, you must use an operating system that supports them. Other security features are optional features which can be purchased, such as security covers. (To find out whether your operating system supports a particular security feature, see the documentation that comes with your operating system.)

### Securing Hardware

One of the best methods for protecting your hardware from theft is to keep it under lock and key. For more protection, you can fasten your server to a stationary object, such as a table, a desk, or a wall. Another approach is to locate critical resources, including your server, in a limited-access area behind locked doors.

The hardware security features of your server include:

- The door lock and keys
- The optional U-bolt facility, which allows you to secure the system to a stationary object using a cable or chain
- The security-cover option

### Door Lock and Keys

A door lock mechanically deters access to the drives. It controls access to the small door that covers the removable media drives as well as the entire front cover.

## Security Features

Two keys are provided with your server. Always store the keys in a safe place. If you lose them, you must order a replacement lock mechanism and keys from IBM.

*Note:* Note that anyone who has the key serial number and manufacturer's address can order duplicate keys, so store the tag in a safe place.

### U-Bolt Facility

If your server is in an accessible area, you might need a method of securing it to a desk, table, or other stationary object. Two holes in the rear panel of the server can accommodate a U-bolt. After a U-bolt is installed, you can use a cable or chain to lock the server in place. (This capability is referred to as a *cabl*e-down or a *bolt-down* feature.)



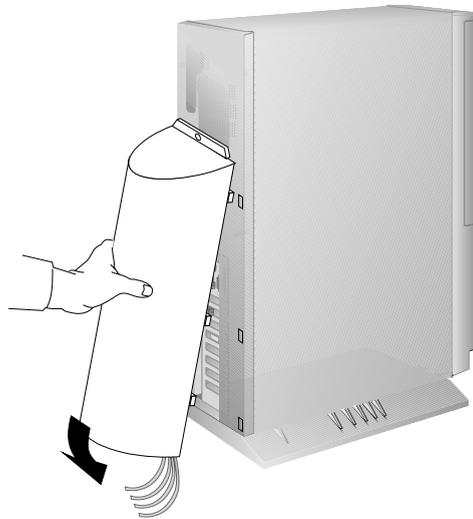
Step-by-step instructions for installing the U-bolt are in your *User's Handbook*.

### Security-Cover Option

At the rear of your server are several connectors that can be used to send and receive data. Anyone with the correct equipment and knowledge can use these connectors to gain access to the data stored on your hard disk and other storage devices. The rear cover of your server accommodates a security cover that prevents access to the connectors.

The security-cover option prevents the cables from being removed from the rear of the server, and should prevent other computers or devices from being attached to the unused connectors.

*Note:* The security cover does not protect against unauthorized access through devices attached outside of the system.



The security-cover option is not a standard feature of your system; it is available from your IBM reseller or marketing representative.

## Security Features

### LogicLock (PCI/Micro Channel Models)

*LogicLock* features, the advanced security features that come with some PC Server 320 models, include tamper-evident switches. This active security feature uses microswitches on the covers to indicate if someone has tried to open the front cover.

### Securing Data

It is very difficult to secure shared information from theft, but an effective method is to limit user access. Only users who need the software or data should be able to access it. This level of access control is provided as a standard feature of most network operating systems. Password protection is another common feature of network operating systems that helps secure data from theft. Passwords, which are easy to use and very effective, help prevent unauthorized users from accessing sensitive files.

Some advanced network management programs can actually audit usage, based on names, adapter addresses, date, time, and unsuccessful attempts to access a file. Such information can help identify users who attempt to access restricted data.

To secure extremely sensitive data, you might want to consider using a commercially available data-encryption tool. These tools encode the files so that they are unintelligible unless a special key is provided. You can use a program or an encryption device to encrypt data. Software programs are usually less expensive than hardware devices, but programs are slower.

### Power-On Password (PCI/Micro Channel Models)

You do not need to use a power-on password to use your server, but a password helps protect the information you store in it. A power-on password can contain any combination of up to seven characters (A-Z, a-z, and 0-9). Keep a record of your password in a secure place.

If you forget the password, you must remove the server cover and remove the battery for at least 15 minutes, unless you have set and know the administrator password. The administrator password can

be entered at the power-on password prompt to unlock the keyboard and mouse. You can then use the Configuration/Setup utility program to set a new power-on password.

The power-on password locks the keyboard and mouse (if attached to the auxiliary-device port) to help prevent unauthorized use of your server. If the mouse is connected to a serial port, the mouse remains active.

### Administrator Password (PCI/Micro Channel Models)

Before setting an administrator (also known as privileged-access) password, it is a good idea to read this section completely. Using this security feature requires some planning and ongoing administration.

The administrator password allows you to control access to the Configuration/Setup utility programs. If an administrator password is set, also use it to access the system setup programs on the Reference Diskette. The administrator password also can be used to override the power-on password. After an administrator password is set, only those who know the password can perform tasks such as:

- Altering computer settings or features controlled by the system programs
- Running diagnostic tests
- Resetting the system after a forced entry (If the server is forced open, a POST error occurs. To clear the error, you must enter the administrator password.)

Your server is shipped with the administrator password feature *Disabled*. You must move a jumper on the system board before an administrator password can be set for the first time. The jumper has two positions:

- The *locked state* prevents an administrator password from being set, changed, or removed. This is the position set at the factory.
- The *change state* allows an administrator password to be set, changed, or removed.

## Security Features

The location of the administrator password jumper is shown on a label inside your server.

The *User's Handbook* describes the procedure for changing the administrator password jumper.

**Attention:** If an administrator password is set, then forgotten, it cannot be overridden or removed. The system board must be replaced in order to access the system programs.

### *How the Administrator Password Works*

Use the administrator password when highly classified information must be protected. Although it can be used with your power-on password, it provides a much higher level of security when used with an operating system that controls access through the use of passwords. This type of operating system is called a *secured or trusted computing base*.

You can use any combination of up to seven characters (A–Z, a–z, and 0–9) for your administrator password, just as you can with your power-on password. For additional security, the two passwords should not be the same.

One important difference between the power-on password and the administrator password is that a forgotten administrator password cannot be overridden or disabled. The single most important reason for setting an administrator password is that when one is set, only those who know the password can access the system programs and modify the hardware or change any of the settings.

If you type the wrong password, Incorrect password appears and the password prompt appears again. After three incorrect attempts, The system is locked message is displayed and you must turn off the server and start again.

### Supervisor Password (PCI/EISA Models)

The supervisor password allows you to control who has access to the Setup program. If a supervisor password is set, you must enter it to use the Setup program. Only someone who knows the current supervisor password can change the supervisor password.

Before you can set a supervisor password, you must first set your selectable drive-startup sequence, as described in your *User's Handbook*.

**Attention:** If a supervisor password is set and then forgotten, it cannot be overridden or removed. If you forget your supervisor password, you must place a service call to regain access to your server.

The password becomes effective immediately after you enter it. After you set the supervisor password, you are prompted to enter it each time you attempt to start the Setup program. See your *User's Handbook* for details about using the supervisor password.

### User Password (PCI/EISA Models)

You do not need to set a user password, but it helps to protect the information that you store in your server. The user password controls access to your operating system and the information stored on your hard disk drives.

The password becomes effective immediately after you enter it. You are prompted to enter the user password each time you start your operating system, after POST occurs. See your *User's Handbook* for details about using the user password.

### Keyboard Password

A keyboard password allows you to lock the keyboard while the system is turned on. This is useful if you leave your system on and unattended. With the keyboard locked, no one can use or restart your system.

The way you set the keyboard password depends on the operating system that you are using. The OS/2 operating system provides keyboard-password protection as a standard feature.

### Selectable Drive Startup

*Selectable drive startup* (sometimes referred to as selectable *boot*) allows you to control the startup sequence of the drives in your server. Each time you turn on the server, it checks the drives as it

## Security Features

looks for the operating system. The order in which the system checks the drives is the *drive-startup sequence*.

In most cases, you do not need to change the *default* drive-startup sequence. However, if you set an administrator password, or are working with multiple hard disk drives, multiple operating systems, or different sized diskette drives, you might want to change the default drive-startup sequence.

The default drive-startup sequence checks the primary diskette drive for a self-starting (*bootable*) diskette. If one is present, the operating system or program is loaded from the diskette. If not, the system checks the primary hard disk for an operating system. If one is present, it is loaded from that hard disk.

If you start the system from a diskette, the drive containing the diskette becomes drive A, regardless of the defined sequence, and the first hard disk selected in the startup sequence becomes drive C. You can choose a startup sequence of up to four drives.

You can *customize* the startup sequence by changing the order in which the system checks the drives. You decide which four drives are the first to be checked, *and* the order in which the system checks them.

### Notes:

1. If a Reference Diskette (Micro Channel models only) is present in a diskette drive which is not in the selectable boot sequence, POST will boot that diskette *only* if you press F1 or (Alt+Ctrl+Ins) at the server startup.
2. When you change the startup sequence, the drive letters also might change. The operating system assigns the drive letters when the system starts. Letters A and B *always* are assigned to diskette drives. Subsequent drive letters can be assigned to any type of drive based on the operating system or the device drivers used.

**Attention:** If you changed your startup sequence, you must be extremely careful when doing *write* operations (for example,

copying, saving, or formatting). You can accidentally overwrite data or programs if you select the wrong drive.

### Securing Data from Loss

There are several methods you can use to prevent the loss of data. You should consider these methods carefully, because some of them affect the performance, reliability, and hardware requirements of the server.

There are primarily three ways that you can protect your data from loss. You can wait until the data accumulates on the server and then make backup copies of all the hard disks. You can configure a disk array to duplicate the data (create a redundant copy) as it is entered, and then store the duplicate copy on a separate hard disk. Or, you can configure a disk array to store the parity information about the data on the array as the data is being entered.

### Backup Copies

A good method for preventing the loss of data is to make copies of the data. That way, in the event of a hardware failure, you can always recover using the copies.

Backing up the entire contents of a hard disk to diskettes can be very time-consuming and, in the case of a network server that has multiple hard disks, might require hundreds of diskettes. A faster and more efficient way to back up the data is to use a tape-backup drive. Using a tape-backup drive, you can copy large volumes of data from the hard disks to a single tape.

There are two problems with making backup copies. The first problem is someone has to remember to do it. The second problem is that you usually need to disconnect the server from the network to make the backup copies.

### Redundant Copies

A convenient way to copy the contents of a hard disk is to duplicate all data as it is being entered. This duplicate copy is then stored on another hard disk. If one hard disk fails, you still have access to the

## Security Features

data on the other. This method is more expensive than backing up to diskettes or tapes, because it doubles the amount of disk-storage space needed.

### Parity Information

Storing parity information about the data as the data is being entered is an efficient, cost effective, and reliable method commonly used to guard against the loss of data. In the event of a hard disk failure, the parity information and the data on the remaining functional disks are used to reconstruct the data that was stored on the failed drive.

### Viruses

Computer viruses are a problem that exists within the personal computer community. A computer virus is a program (or instructions hidden within a program) that *infects* other programs by modifying them without your knowledge. Like any other program, the virus can do anything it is programmed to do. Some viruses are practical jokes, causing unusual or erratic screen behavior. Others are destructive, erasing or damaging files or overloading memory and communication networks.

Viruses are difficult to detect. Many stay inactive until triggered by a specified event such as a date, command, or some other operation. Others are activated when an infected program is started a specified number of times. When the symptoms of the virus appear, it might be difficult to determine if the problem is a hardware failure, a problem in the software, or a virus in action.

Virus-detection programs examine files and look for patterns associated with these viruses, or look for changes in the size of files. These programs are best used as a preventive measure to detect a virus before it becomes widespread or causes damage. Many computer users check for viruses on a regular basis.

On PCI/Micro Channel models, you can use the built in setup and configuration program to enable or disable a virus-detection program that examines files at system startup. On PCI/EISA models, you can use the built in setup and configuration program to

enable or disable write protecting of the hard disk boot sector (see your *User's Handbook* for details).

When a virus is found, it must be removed. This might be as simple as replacing a file, or it might require the assistance of a trained technician. Some virus-detection programs can remove viruses and repair the damage caused by relatively benign viruses.

Viruses are generally spread unknowingly from computer to computer when programs are exchanged or shared. If you don't know where a program came from, be careful. Several other programs are available that can detect the presence of many known viruses.

Most reputable program distributors and bulletin-board owners scan their files to guard against viruses and maintain records to identify program owners.

Here are a few tips to help guard against computer viruses:

- Write protect original program diskettes before using them. This ensures the diskettes will not be infected if a virus is already present in your system.
- Avoid using programs and diskettes from unknown sources.
- If you use programs provided from public-domain software distributors or bulletin-board services, find out what precautions they take to guard against viruses.
- Back up all critical data and programs regularly.
- Watch out for changes in file sizes (when they shouldn't change).
- Use password protection to limit access to your system or network.

Remember, not every problem is caused by a virus. If your system starts acting erratically, refer to your *User's Handbook* for information about testing the system.

### Erased Files

Erasing a file from a diskette or hard disk does not destroy the file. With the right type of software, all or part of an erased file can be reclaimed. This can cause a security risk if you sell a system or give someone a diskette that once contained classified or confidential information.

One way to help ensure that no readable information is left on a hard disk is to do a low-level format. An operating-system format operation does not remove all information from a hard disk.

The operating-system format operation works a little differently with diskettes. This format operation writes a repeated pattern over the entire surface. Any information that was on the diskette becomes unreadable.

Depending on the type of information stored, your company might require additional safeguards.

### Backup Power Supply

To prevent the loss of data caused by a power fluctuation, you might consider installing a backup power supply. There are two basic types of commercially available backup power supplies: *uninterruptible* and *standby*.

### Uninterruptible Power Supplies

An uninterruptible power supply provides power when the main power source is lost. An uninterruptible power supply connects directly to the main power source (electrical outlet), and then the server connects to the power supply. The power supply transfers the power from the main power source to its internal battery and its internal battery then provides power to the server. The advantages of uninterruptible power supplies are that they require no switching time (because they are always on), and they protect the server from power surges. A disadvantage is that they usually cost more than standby power supplies.

## Standby Power Supplies

A standby power supply waits until it detects a drop in voltage; it then switches on and provides power to the server until its battery power is depleted. An advantage of a standby power supply is low cost. It is usually less expensive than an uninterruptible power supply. A disadvantage of a standby power supply is the amount of time that it needs to switch itself on; the more time it takes, the greater the chance of losing data.

## Security Features

# Appendix A. Product Warranties and Notices

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International Business Machines Corporation

Armonk, New York, 10504

## Statement of Limited Warranty

*The warranties provided by IBM in this Statement of Limited Warranty apply only to Machines you originally purchase for your use, and not for resale, from IBM or an IBM authorized reseller. The term "Machine" means an IBM machine, its features, conversions, upgrades, elements, or accessories, or any combination of them. Machines are subject to these terms only if purchased in the United States or Puerto Rico, or Canada, and located in the country of purchase. If you have any questions, contact IBM or your reseller.*

**Machine:** IBM PC Server 320

**Warranty Period\*:** Three Years, On-Site Service

*\*Elements and accessories are warranted for three months. Contact your place of purchase for warranty service information.*

## Production Status

Each Machine is manufactured from new parts, or new and serviceable used parts (which perform like new parts). In some cases, the Machine may not be new and may have been previously installed. Regardless of the Machine's production status, IBM's warranty terms apply.

## The IBM Warranty

IBM warrants that each Machine 1) is free from defects in materials and workmanship and 2) conforms to IBM's Official Published Specifications. IBM calculates the expiration of the warranty period from the Machine's Date of Installation. The date on your receipt is the Date of Installation, unless IBM or your reseller informs you otherwise.

During the warranty period, IBM or your reseller will provide warranty service under the type of service designated for the Machine and will manage and install engineering changes that apply to the Machine. IBM or your reseller will specify the type of service.

For a feature, conversion, or upgrade, IBM or your reseller may require that the Machine on which it is installed be 1) the designated, serial-numbered Machine and 2) at an engineering-change level compatible with the feature, conversion, or upgrade. Some of these transactions (called "Net-Priced" transactions) may include additional parts and associated replacement parts that are provided on an exchange basis. All removed parts become the property of IBM and must be returned to IBM.

Replacement parts assume the remaining warranty of the parts they replace.

If a Machine does not function as warranted during the warranty period, IBM or your reseller will repair or replace it (with a Machine that is at least functionally equivalent) without charge. If IBM or your reseller is unable to do so, you may return it to your place of purchase and your money will be refunded.

## Product Warranties and Notices

If you transfer a Machine to another user, warranty service is available to that user for the remainder of the warranty period. You should give your proof of purchase and this Statement to that user.

### Warranty Service

To obtain warranty service for the Machine, you should contact your reseller or call IBM. In the United States, call the IBM Personal Systems HelpCenter at **1-800-772-2227**. In Canada, call the IBM Personal Systems HelpCenter at **1-800-465-4955**. You may be required to present proof of purchase.

Depending on the Machine, the service may be 1) a “Repair” service at your location (called “On-site”) or at one of IBM’s or a reseller’s service locations (called “Carry-in”) or 2) an “Exchange” service, either On-site or Carry-in.

When a type of service involves the exchange of a Machine or part, the item IBM or your reseller replaces becomes its property and the replacement becomes yours. The replacement may not be new, but will be in good working order and at least functionally equivalent to the item replaced.

It is your responsibility to:

1. obtain authorization from the owner (for example, your lessor) to have IBM or your reseller service a Machine that you do not own;
2. where applicable, before service is provided —
  - a. follow the problem determination, problem analysis, and service request procedures that IBM or your reseller provide,
  - b. secure all programs, data, and funds contained in a Machine,
  - c. inform IBM or your reseller of changes in a Machine’s location, and
  - d. for a Machine with exchange service, remove all features, parts, options, alterations, and attachments not under warranty service. Also, the Machine must be free of any legal obligations or restrictions that prevent its exchange; and
3. be responsible for loss of, or damage to, a Machine in transit when you are responsible for the transportation charges.

### Extent of Warranty

IBM does not warrant uninterrupted or error-free operation of a Machine.

Misuse, accident, modification, unsuitable physical or operating environment, improper maintenance by you, or failure caused by a product for which IBM is not responsible may void the warranties.

THESE WARRANTIES REPLACE ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. HOWEVER, SOME LAWS DO NOT ALLOW THE EXCLUSION OF IMPLIED WARRANTIES. IF THESE LAWS APPLY, THEN ALL EXPRESS AND IMPLIED WARRANTIES ARE LIMITED IN DURATION TO THE WARRANTY PERIOD. NO WARRANTIES APPLY AFTER THAT PERIOD.

## Product Warranties and Notices

In Canada, warranties include both warranties and conditions.

Some jurisdictions do not allow limitations on how long an implied warranty lasts, so the above limitation may not apply to you.

### **Limitation of Liability**

Circumstances may arise where, because of a default on IBM's part (including fundamental breach) or other liability (including negligence and misrepresentation), you are entitled to recover damages from IBM. In each such instance, regardless of the basis on which you are entitled to claim damages, IBM is liable only for:

1. bodily injury (including death), and damage to real property and tangible personal property; and
2. the amount of any other actual loss or damage, up to the greater of \$100,000 or the charge for the Machine that is the subject of the claim.

Under no circumstances is IBM liable for any of the following:

1. third-party claims against you for losses or damages (other than those under the first item listed above);
2. loss of, or damage to, your records or data; or
3. economic consequential damages (including lost profits or savings) or incidental damages, even if IBM is informed of their possibility.

Some jurisdictions do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific legal rights and you may also have other rights which vary from jurisdiction to jurisdiction.



## Electronic Emission Notices Federal Communications Commission (FCC) Statement

**Note:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult an IBM authorized dealer or service representative for help.

Properly shielded and grounded cables and connectors must be used in order to meet FCC emission limits. Proper cables and connectors are available from IBM authorized dealers. IBM is not responsible for any radio or television interference caused by using other than recommended cables and connectors or by unauthorized changes or modifications to this equipment. Unauthorized changes or modifications could void the user's authority to operate the equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

## Notices

### **Industry Canada Class B Emission Compliance Statement**

This Class B digital apparatus meets the requirements of the Canadian Interference-Causing Equipment Regulations.

### **Avis de conformité à la réglementation d'Industrie Canada**

Cet appareil numérique de la classe B respecte toutes les exigences du Règlement sur le matériel brouilleur du Canada.

## Power Cords

For your safety, IBM provides a power cord with a grounded attachment plug to use with this IBM product. To avoid electrical shock, always use the power cord and plug with a properly grounded outlet.

IBM power cords used in the United States and Canada are listed by Underwriter's Laboratories (UL) and certified by the Canadian Standards Association (CSA).

For units intended to be operated at 115 volts: Use a UL-listed and CSA-certified cord set consisting of a minimum 18 AWG, Type SVT or SJT, three-conductor cord, a maximum of 15 feet in length and a parallel blade, grounding-type attachment plug rated 15 amperes, 125 volts.

For units intended to be operated at 230 volts (U.S. use): Use a UL-listed and CSA-certified cord set consisting of a minimum 18 AWG, Type SVT or SJT, three-conductor cord, a maximum of 15 feet in length and a tandem blade, grounding-type attachment plug rated 15 amperes, 250 volts.

For units intended to be operated at 230 volts (outside the U.S.): Use a cord set with a grounding-type attachment plug. The cord set should have the appropriate safety approvals for the country in which the equipment will be installed.

IBM power cords for a specific country are usually available only in that country:

<b>IBM Power Cord Part Number</b>	<b>Used in These Countries</b>
13F9940	Argentina, Australia, China (PRC), New Zealand, Papua New Guinea, Paraguay, Uruguay, Western Samoa
13F9979	Afghanistan, Algeria, Andorra, Angola, Austria, Belgium, Benin, Bulgaria, Burkina Faso, Burundi, Cameroon, Central African Rep., Chad, Czech Republic, Egypt, Finland, France, French Guiana, Germany, Greece, Guinea, Hungary, Iceland, Indonesia, Iran, Ivory Coast, Jordan, Lebanon, Luxembourg, Macau, Malagasy, Mali, Martinique, Mauritania, Mauritius, Monaco, Morocco, Mozambique, Netherlands, New Caledonia, Niger, Norway, Poland, Portugal, Romania, Senegal, Slovakia, Spain, Sudan, Sweden, Syria, Togo, Tunisia, Turkey, former USSR, Vietnam, former Yugoslavia, Zaire, Zimbabwe
13F9997	Denmark
14F0015	Bangladesh, Burma, Pakistan, South Africa, Sri Lanka
14F0033	Antigua, Bahrain, Brunei, Channel Islands, Cyprus, Dubai, Fiji, Ghana, Hong Kong, India, Iraq, Ireland, Kenya, Kuwait, Malawi, Malaysia, Malta, Nepal, Nigeria, Polynesia, Qatar, Sierra Leone, Singapore, Tanzania, Uganda, United Kingdom, Yemen, Zambia
14F0051	Liechtenstein, Switzerland
14F0069	Chile, Ethiopia, Italy, Libya, Somalia
14F0087	Israel
1838574	Thailand
62X1045	Bahamas, Barbados, Bermuda, Bolivia, Brazil, Canada, Cayman Islands, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Japan, Korea (South), Liberia, Mexico, Netherlands Antilles, Nicaragua, Panama, Peru, Philippines, Saudi Arabia, Suriname, Taiwan, Trinidad (West Indies), United States of America, Venezuela

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- The ANSI/EIA Standard—440-A: *Fiber Optic Terminology*. Copies may be purchased from the Electronic Industries Association, 2001 Pennsylvania Avenue, N.W., Washington DC 20006. Definitions are identified by the symbol (E) after the definition.
- The *Information Technology Vocabulary*, developed by Subcommittee 1, Joint Technical Committee 1, of the International Organization for Standardization and the International Electrotechnical Commission (ISO/IEC JTC1/SC1). Definitions of published parts of this vocabulary are identified by the symbol (I) after the definition; definitions from draft international standards, committee drafts, and working papers being developed by ISO/IEC JTC1/SC1 are identified by the symbol (T) after the definition, indicating that final agreement has not yet

been reached among the participating National Bodies of SC1.

## A

**access time.** The time interval between the instant at which a call for data is initiated and the instant at which the delivery of data is completed.

**adapter.** A printed circuit board that modifies the system unit to allow it to operate in a particular way.

**address.** (1) A value that identifies a register or a particular part of storage. The value is represented by one or more characters. (2) The location in the storage of a computer where data is stored. (3) To refer to a specific storage location by specifying the value that identifies the location.

**address bus.** The path used for the transmission of address information in a computer.

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

**ANSI.** American National Standards Institute. An organization consisting of producers, consumers, and general interest groups, that establishes the procedures by which accredited organizations create and maintain

voluntary industry standards in the United States.

**application.** The use to which an information processing system is put; for example, a payroll application, an airline reservation application, a network application.

**application program.** (1) A program that is specific to the solution of an application problem. Synonymous with application software. (T) (2) A program written for or by a user that applies to the user's work, such as a program that does inventory control or payroll. (3) A program used to connect and communicate with stations on a network, enabling users to perform application-oriented activities.

**arbitration.** A process that determines which device or subsystem gains control of a bus when two or more devices or subsystems simultaneously compete for control.

**architecture.** See computer architecture.

## B

**bank.** An aggregation of similar devices, such as single inline memory modules, connected to each other and used cooperatively.

**BIOS (Basic Input/Output**

**System).** Code that controls basic hardware operations such as interactions 0 and with diskette drives, hard disk drives, and the keyboard.

**bit.** Either of the digits 0 or 1 when used in the binary numeration system. Synonymous with binary digit. (T)

**bridge.** A functional unit that interconnects two local area networks that use the same logical link control protocol but may use different medium access control protocols.

**buffer.** (1) A routine or storage used to compensate for a difference in rate of flow of data, or time of occurrence of events, when transferring data from one device to another. (A) (2) A portion of storage used to hold input or output data temporarily.

**bus.** One or more conductors used for transmitting signals, data, or power. See also address bus and data bus.

**bus master.** A device or subsystem that controls data transfers between itself and a subordinate

**byte.** A string that consists of a number of bits, usually 8, that are treated as a unit and represent a character.

## C

**cable.** The physical medium for transmitting signals; it includes copper conductors and optical fibers.

**cache.** A buffer storage that contains frequently accessed instructions and data; it is used to reduce access time.

**client.** A functional unit that receives shared services from a server. (T)

**clock.** A device that generates periodic, accurately spaced signals used for purposes such as timing, regulation of the operations of a processor, or generation of interrupts. (T)

**clock cycle.** In microprocessors, a unit of time expressed in nanoseconds (ns) that measures the period between clock signals.

**code.** A collection of instructions that is in a form that can be read and processed by a computer.

**compatibility.** The capability of a hardware or software component to conform to the interface requirements of a given computer without adversely affecting its functions.

**computer architecture.** (1) The logical structure and functional

characteristics of a computer, including the interrelationships among its hardware and software components. (2) The organizational structure of a computer system, including hardware and software.

**configuration.** The manner in which the hardware and software of an information processing system are organized and interconnected. (T)

**configure.** To set up a computer for operation by describing to the system the devices, optional features, and programs installed in the computer.

**control.** The determination of the time and order in which the parts of a computer and the devices that contain those parts perform the input, processing, storage, and output functions.

**controller.** A device that coordinates and controls the operation of one or more input/output devices, such as workstations, and synchronizes the operation of such devices with the operation of the system as a whole.

**cycle.** (1) An interval of space or time in which one set of events or phenomena is completed. (A) (2) A complete vibration, electric oscillation, or alternation of current.

## D

**DASD.** Direct access storage device.

**data.** (1) A re-interpretable representation of information in a formalized manner suitable for communication, interpretation, or processing. Operations can be performed upon data by humans or by automatic means. (T) (2) Any representations such as characters or analog quantities to which meaning is or might be assigned. (A)

**data bus.** A bus used to communicate data internally and externally to and from a processing unit, storage, and peripheral devices. (A)

**device.** A mechanical, electrical, or electronic piece of equipment designed to serve a special purpose or perform a special function.

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

**direct access storage device (DASD).** A nonvolatile-storage device, such as a diskette drive, hard disk drive, or CD-ROM drive, in which access time is effectively independent of the location of the data on the storage medium.

**direct memory access (DMA).** The transfer of data between memory and input/output devices without microprocessor intervention.

**disk array.** Two or more hard disks interconnected to increase security, performance, or reliability.

**disk duplexing.** A method of storing data whereby the data from one hard disk is duplicated on another, with each hard disk drive using its own hard-disk controller. Contrast with disk mirroring.

**diskette.** A small magnetic disk enclosed in a jacket. (T)

**disk mirroring.** A method of storing data whereby the data from one hard disk is duplicated on another, with both hard disk drives sharing a single hard-disk controller. Contrast with disk duplexing.

**DMA.** Direct memory access.

**dot pitch.** In color video displays, the distance on a scan line (expressed in millimeters) from the center of one phosphor dot to the center of the next phosphor dot of the same color.

## E

**EEPROM.** electrically erasable programmable read-only memory.

**extended industry standard architecture (EISA).** An expansion bus architecture used in a network server that provides compatibility among hardware components.

**electrically erasable programmable read-only memory (EEPROM).**

**EPROM** that can be reprogrammed while it is in the computer.

**EPROM.** Erasable programmable read-only memory.

**erasable programmable read-only memory (EPROM).** A PROM that can be erased by a special process and reused. (T)

**execution unit.** A logical unit of a microprocessor that performs the arithmetic and logical operations specified by the microprocessor instruction set.

## F

**file.** A named set of records stored or processed as a unit. (T)

**file server.** A high-capacity disk storage device or a computer that each computer on a network can use to access and retrieve files that can be shared among the attached computers.

**floating-point unit (FPU).** In microprocessors, an execution unit that executes floating-point arithmetic instructions.

**frame.** (1) A data structure that consists of fields, predetermined by a protocol, for the transmission of user data and control data. The composition of a frame, especially the number and types of fields, may vary according to the type of protocol. (T)

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

**frequency-division multiplexing (FDM).** Division of a transmission facility into two or more channels by splitting the frequency band transmitted by the channel into narrower bands, each of which constitutes a distinct channel. See also time-division multiplexing.

## G

**gateway.** A functional unit that interconnects two computer networks with different network architectures. A gateway connects networks or systems of different architectures. A bridge interconnects networks or systems with the same or similar architectures.

**GB.** Gigabyte.

**gigabyte.** Approximately 1 000 000 000 bytes.

## H

**hard disk.** A rigid magnetic disk such as the internal disks used in the system units of personal-computer systems and in external hard disk drives.

**hard disk drive.** A disk drive that reads and writes data on rigid disks and can be installed in or connected to a computer.

**hardware.** (1) All or part of the physical components of an information processing system, such as computers or peripheral devices. (T) (2) The equipment, as opposed to the programming, of a computer. (3) Contrast with software.

**hertz (Hz).** A unit of frequency equal to one cycle per second.

**hot-swappable.** Refers to a hardware component that can be installed or removed without disturbing the operation of any other resource that is not connected to, or dependent on, this component.

## I

**icon.** A graphic symbol, displayed on a screen, that a user can point to with a device such as a mouse in order to select a particular function or software application. Synonymous with pictogram. (T)

**initialization.** Preparation of a system, device, or program for operation.

**input/output.** Pertaining to a device, process, or channel involved in data input, data output, or both.

**input/output device.** A device in a data processing system by means of which data can be entered into the system, received from the system, or both. (I) (A)

**instruction.** A statement that specifies an operation to be

performed by a microprocessor, and that identifies data involved in the operation.

**integer unit.** In microprocessors, an execution unit that executes logical and integer arithmetic instructions.

**I/O.** Input/output.

**industry standard architecture (ISA).** An expansion bus architecture used in a network server that provides compatibility among hardware components.

**ISO.** International Organization for Standardization. An organization of national standards bodies from various countries established to promote development of standards to facilitate international exchange of goods and services, and develop cooperation in intellectual, scientific, technological, and economic activity.

## K

**KB.** Kilobyte.

**kilobyte.** Approximately 1000 bytes.

## L

**LAN.** See local area network.

**load.** To bring all or part of a computer program into memory from auxiliary storage so that the computer can run the program.

**local area network (LAN).** (1) A computer network located on a user's premises within a limited geographical area. Communication within a local area network is not subject to external regulations; however, communication across the LAN boundary may be subject to some form of regulation. (T) (2) A network in which a set of devices are connected to one another for communication and that can be connected to a larger network.

**logical.** (1) Pertaining to content or meaning as opposed to location or actual implementation. (A) (2) Pertaining to a view or description of data that does not depend on the characteristics of the computer system or the physical storage. (A) (3) Contrast with physical. (A)

## M

**math coprocessor.** In personal-computer systems, a microprocessor that supplements the operations of the system microprocessor, enabling the computer to perform complex mathematical operations in parallel with other operations.

**MB.** Megabyte.

**MBps.** One million bytes per second.

**Mbps.** One million bits per second.

**medium.** A physical material in or on which data may be represented.

**megabyte.** Approximately 1 000 000 bytes.

**megahertz (MHz).** A unit of measure of frequency equal to 1 000 000 cycles per second.

**memory.** Addressable storage space in the computer that is used for temporary storage of instructions and data while a program is running, or for permanent storage of microcode. Contrast with auxiliary storage.

**menu.** A list of options displayed to the user by a data processing system, from which the user can select an action to be initiated. (T)

**microprocessor.** A processor whose elements have been miniaturized into one or a few integrated circuits. (T)

**millimeter (mm).** One thousandth of a meter.

**millisecond (ms).** One thousandth of a second.

**milliwatt (mw).** One thousandth of a watt.

**modem (modulator/demodulator).** (1) A functional unit that modulates and demodulates signals. One of the functions of a modem is to enable digital data to be transmitted over analog transmission facilities. (T) (A) (2) A device that converts digital data from a computer to an analog signal that can be transmitted on a telecommunication

line, and converts the analog signal received to data for the computer.

**multiplexing.** In data transmission, a function that permits two or more data sources to share a common transmission medium so that each data source has its own channel. (I)  
(A)

**multitasking.** A mode of operation that provides for concurrent performance, or interleaved execution, of two or more tasks. (I)  
(A)

## N

**nanosecond (ns).** One thousand millionth ( $10^{-9}$ ) of a second.

**network.** (1) An arrangement of nodes and connecting branches. (T)  
(2) A configuration of data processing devices and software connected for information interchange.

**network server.** See server.

**nonvolatile.** (1) Pertaining to a storage device whose contents are not lost when power is cut off. (T)  
(2) Contrast with volatile.

**normalization.** The process of restructuring a relation for the purpose of reducing it to its simplest form, so that each of its attributes is based on a simple domain that consists of single, noncomposite values. (A)

**nonvolatile random access memory (NVRAM).** Pertaining to a random access storage device whose contents are not lost when power to the computer is turned off. It relies on an alternate source of power, such as the system battery, to retain its contents.

## O

**operating system.** Software that controls the execution of programs and that may provide services such as resource allocation, scheduling, input/output control, and data management. Although operating systems are predominantly software, partial hardware implementations are possible. (T)

## P

**parallel.** Pertaining to a process in which all events occur within the same time interval, each handled by a separate but similar functional unit; for example, the parallel transmission of the bits of a computer word along the lines of an internal bus.

**parity bit.** A check bit appended to an array of binary digits to make the sum of all the binary digits, including the check bit, always odd or always even. (A)

**peripheral component interconnect (PCI).** A local bus architecture used in a network server that allows for interconnecting a system processor

with tightly-coupled peripherals and memory.

**performance.** One of the two major factors, together with facility, on which the total productivity of a system depends. Performance is largely determined by a combination of throughput, response time, and availability.

**physical.** (1) Pertaining to actual implementation or location as opposed to conceptual content or meaning. (A) (2) Contrast with logical. (A)

**pipeline.** In microprocessors, a technique used to shorten the critical path of instruction execution by performing multiple execution stages simultaneously.

**port.** An access point for data entry or exit.

**processing.** The performance of logical operations and calculations on data, including temporary retention of data in microprocessor storage while the data is being operated on.

**processor.** A functional unit that interprets and executes instructions. A processor consists of at least an instruction control unit and an arithmetic and logic unit. (T) See microprocessor and central processing unit.

**program.** (1) A sequence of instructions that a computer can interpret and execute. (2) To

design, write, modify, and test computer programs. (I) (A)

**programmable read-only memory (PROM).** A storage device that, after being written to once, becomes read-only memory. (T) (A)

**prompt.** A visual or audible message sent by a program to request the user's

**PUN.** Physical unit number

## R

**RAID.** Redundant array of independent disks

**RAS.** Reliability, availability, and serviceability

**random access memory (RAM).** (1) A storage device in which data can be written and read. (2) A storage device into which data is written and from which data is read in a nonsequential manner.

**read.** To acquire or interpret data from a storage device, from a data medium, or from another source.

**read-only memory (ROM).** Memory in which stored data cannot be modified by the user except under special conditions. See also EEPROM, EPROM, and PROM.

**record.** (1) A set of data treated as a unit. (2) A set of one or more related data items grouped for processing.

**refresh.** (1) To recharge a memory location in volatile memory with an electric current so that it retains a state or binary value. (2) In computer graphics, the process of repeatedly producing a display image on a display surface so that the image remains visible.

**register.** (1) An integrated circuit that contains 8, 16, or 32 storage locations, each of which can store 1 bit of binary data. See also binary. (2) An area that stores binary data while it is being processed by the computer.

**resolution.** In video displays, a measure of the sharpness of an image, expressed as the number of lines and columns on the display screen or the number of pels per unit of area.

## S

**SCSI.** Small computer system interface.

**seek time.** The time required for the access arm of a direct access storage device to be positioned on the appropriate track.

**sequential.** Pertaining to a process in which all events occur one after the other, without any time lapse between them.

**sequential access.** The capability to enter data into a storage device or a data medium in the same sequence as the data is ordered, or to obtain

data in the same order as it has been entered.

**serial.** Pertaining to a process in which all events occur one after the other; for example, serial transmission of the bits of a character.

**server.** (1) A functional unit that provides shared services to workstations over a network. (2) In a network, a data station that provides facilities to other stations.

**small computer system interface (SCSI).** A standard input/output interface used by personal computers.

**socket.** A receptacle for a microchip.

**software.** (1) All or part of the programs, procedures, rules, and associated documentation of a computer. Software is an intellectual creation that is independent of the medium on which it is recorded. (2) Contrast with hardware.

**SQL.** Structured query language.

**startup sequence.** In personal-computer systems, the order that the computer uses to search the direct access storage devices for an operating system.

**storage.** A functional unit into which data can be placed, in which it can be retained, and from which it can be retrieved.

**subsystem.** In computers, a secondary or subordinate system, usually capable of operating independently of a controlling system, and usually having a single purpose, such as displaying video or reading from and writing to hard disks. A subsystem can be integrated into the system board or on an adapter.

**superscalar.** In a microprocessor, a technique in which multiple independent instructions are issued per clock cycle.

**swap space.** In virtual memory systems, external storage allocated to program and memory images.

**symmetric multiprocessing (SMP).** In personal-computer systems, a multiprocessing design that enables two or more microprocessors to run concurrently and work independently, with each microprocessor capable of performing any application task.

**system board.** In a system unit, the main circuit board that supports a variety of basic system devices, such as a keyboard or a mouse, and provides other basic system functions.

**system unit.** In personal-computer systems, the part of the computer that contains the processor circuitry, read-only memory (ROM), random

access memory (RAM), and the I/O channel.

## T

**TB.** Terabyte.

**terabyte.** Approximately 1 000 000 000 000 bytes.

**throughput.** A measure of the amount of work performed over a period of time, for example, number of jobs per day.

**time-division multiplexing.** Division of a transmission facility into two or more channels by allotting the common channel to several different information channels, one at a time. See also frequency-division multiplexing.

**token.** In a local area network, the symbol of authority passed successively from one data station to another to indicate the station temporarily in control of the transmission medium. Each data station has an opportunity to acquire and use the token to control the medium. A token is a particular message or bit pattern that signifies permission to transmit.

**transaction.** An exchange between a workstation and another device that accomplishes a particular action or result.

## U

**utility program.** (1) A computer program in general support of computer processes; for example, a diagnostic program, a trace program, a sort program. (2) A program designed to perform an everyday task such as copying data from one storage device to another.

## V

**VDRAM.** Video dynamic random access memory

**vertical-refresh rate.** The rate, measured in hertz, at which a display image is redrawn from top to bottom.

**virtual.** Pertaining to a functional unit that appears to be real, but whose functions are accomplished by other means.

**volatile.** (1) Pertaining to a storage device whose contents are lost when power is cut off. (2) Contrast with nonvolatile.

## W

**wait state.** A period during which a microprocessor suspends processing while waiting for a response to a request for an unavailable resource.

**workstation.** (1) A functional unit at which a user works. A workstation often has some processing capability. (2) A terminal or microcomputer, usually one that is connected to a mainframe or to a network, at which a user can perform applications.

**write.** To make a permanent or transient recording of data in a storage device or on a data medium.

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