OBJECTIVES

This chapter covers the following CompTIA-specified objectives for the Installation section of the Server+:

1.1 Conduct pre-installation planning activities. Examples of concepts and modules include the following:

- Plan the installation

- Verify the installation plan

- Verify hardware compatibility with operating system

- Verify power sources, space, Uninterruptible Power Supply and network availability

- Verify that all of the correct components and cables for the network server have been delivered

▶ Every server hardware specialist should prepare for the installation of a network server by checking the installation plan and verifying that all hardware components have been delivered.

1.2 Install hardware using ESD best practices (boards, drives, processors, memory, internal cable, etc.) Examples of modules include the following:

- Mount the rack installation

- Cut and crimp network cabling

- Install UPS

- Verify SCSI ID configuration and termination

CHAPTER 2

1.0—Installation

OBJECTIVES

- Install external devices (e.g., keyboards, monitors, subsystems, modem rack, etc.)

- Verify power-on via power-on sequence

▶ Every server hardware specialist should be capable of installing server hardware components while following the best practices to avoid electrostatic discharge (ESD), which could damage delicate network server components. A server hardware specialist should be able to install all the components of a network server.

OUTLINE

To prepare for the Installation objectives of the Server+ exam, do the following:

▶ Read the objectives at the beginning of this chapter.

▶ Study the information in this chapter.

▶ Review the objectives again.

▶ Answer the Review and Exam Questions at the end of the chapter and check your results.

▶ Use the ExamGear test engine on the CD-ROM that accompanies this book for additional exam questions concerning this material.

▶ Review the Test Tips available in various places in this chapter. Make certain that you understand the information in the Test Tip. If you don't fully understand the Test Tip, review the information in the chapter related to this topic.

INTRODUCTION

The Installation section covers the pre-installation and installation of network server hardware. This section is the topic of approximately 17% of the exam questions.

This chapter covers the two objectives of the Installation job dimension. The first objective deals with reviewing the installation plan, checking all the network server hardware, and checking that the installation site is ready for the network server to be installed. The second objective covers the actual installation of the network server hardware. This objective ends with an actual power-on of the network server to see that all the network server hardware is recognized after installation.

PLANNING FOR INSTALLATION

▶ 1.1 Conduct pre-installation planning activities. These activities include:

- Plan the installation

- Verify the installation plan

- Verify hardware compatibility with operating system

- Verify power sources, space, UPS and network availability

- Verify that all correct components and cables have been delivered

The Installation Plan

The installation plan is a guide that the server hardware specialist uses to install the network server. It should contain such details as the following:

◆ The exact location where the server is to be installed

◆ The location of the network connection for the server

◆ The location of the power outlet for the server

◆ A complete list of the hardware for the server

◆ The role that the network server will take in the network

As discussed in Chapter 1, "0.0—Planning," the *installation plan* is a written document that should have been created by a network engineer during the initial phases of the discussion to acquire the network server (see the section "The Installation Plan" in Chapter 1). It takes into account the role the server will play in the network. The hardware components of the server are dictated by the server's role in the network.

Verifying the Installation Plan

The first step that the server hardware specialist should attempt is to verify that everything specified in the installation plan is ready and available before beginning the installation. Verification activities include the following:

◆ Verify that the location where the server is to be installed is ready for the installation.

◆ Verify that the power outlet for the network server is available and active. (Test with a volt/ohm meter.)

◆ Verify that the network connection is available and active.

◆ Verify that all the hardware for the network server has arrived and that the hardware is as specified in the installation plan.

Verifying Hardware Compatibility with the Operating System

Network operating systems are generally tested to see that they work with the various hardware components that you use to assemble a network server. Most operating system vendors publish a list of hardware that they certify will work with their software. Always check the vendor's hardware compatibility list for the network operating system vendor and make sure that all the hardware for the network server is on the list.

The latest hardware compatibility list for the following network operating systems can be found at the following Web sites:

◆ **Microsoft Windows NT and Windows 2000.**
www.microsoft.com/hcl/default.asp

- ◆ **Novell NetWare.** `http://developer.novell.com/yespgm/hardwarecert.htm` This site gives information about Novell Yes, Tested and Approved program.

- ◆ **Linux (Red Hat).** `www.redhat.com/support/hardware/`

- ◆ **Linux (SuSE).** `http://cdb.suse.de/cdb_english.html`

- ◆ **Caldera OpenLinux.** `www.calderasystems.com/support/hardware/`

- ◆ **IBM OS/2.** `http://service.software.ibm.com/os2ddpak/html/index.htm`

Verifying the Installation Site

After reading and verifying the installation plan, the server hardware specialist should visit the installation site and verify the items listed in the installation plan. The "Installation Plan Checklist" shown in the following Figures 2.1 through 2.5 can be used as a guide to verify the installation plan. A copy of the "Installation Plan Checklist" is included as a Microsoft Word document on the CD-ROM that accompanies this book.

Verifying the Power Source

The server hardware specialist should verify that the power needed for the network server is actually available and live. Be sure to check that the voltage for the power source is correct by using a volt/ohm meter or a digital multimeter. The correct voltage for North America and Latin America is a nominal 120 Volts. The correct voltage for Europe, the Middle East, and Africa is a nominal 230 Volts. The power source also should be on a power circuit unto itself.

Also check that the power source has the correct amperage rating and that power plug is of the correct configuration. Because the UPS is the component that is to be plugged into the power source, this information can be found in the UPS documentation. The UPS may require a 20-amp or a 30-amp circuit, instead of the more common 15-amp circuit. The UPS also may have a special locking power plug, which of course would require a special power socket.

N O T E **Add to Tool Kit** A server hardware specialist's tool kit should include a volt/ohm meter.

FIGURE 2.1
Installation Plan Checklist.

Installation Plan Checklist

Network Server Role _____

Network Server Operating System _____

Network Server Operating System Version Number_____

Network Server Operating System Patch or Service Pack Level _____

Server Hardware Components

Network Server Memory _____

Removable Disk Drives _____

      CD-ROM (Brand, Model, Speed)_____
      DVD-ROM (Brand, Model, Speed) _____
      Floppy Disk Drive 3.5" (Brand, Model, Speed)_____

Tape Back System (Brand, Model, Speed) _____

Video Adapter (Brand, Model, Video RAM, Maximum Resolution) _____

_____

Uninterruptible Power Supply (Brand, Model, VA rating)

_____

Server Management Adapter (Brand, Model)

_____

Network Interface Card(s) (Brand, Model, Type, Speed)

    1._____
    2._____
    3._____
    4._____

Modem (Brand, Model, Speed)

_____

IDE/ATA/EIDE/ATA2 Hard Disk Drives (Brand, Model, Interface, Speed)

    1._____
    2._____
    3._____
    4._____

Site Checklist

Is space available to install the new network server?_____

Is there a working network connection available for the new network server?_____

Is electrical power available for the new network server?_____

      Is the electrical power of the right voltage?_____

      Is the electrical power of the right amperage?_____

      Do the electrical receptacles match the electrical plugs on the UPS?_____

Does the installation site have enough cooling to support the new network server?_____

Is the installation site secure?_____

FIGURE 2.2
Site Checklist.

IDE/ATA/EIDE/ATA2 Disk Controller

1. Disk Controller Brand Model_____

       Channel 1 - Device 1 (Master/Slave/CSEL)_____

       Channel 1 - Device 2(master/Slave/CSEL)_____

       Channel 2 - Device 1 (Master/Slave/CSEL)_____

       Channel 2 - Device 2 (Master/Slave/CSEL)_____

FIGURE 2.3
IDE/ATA/EIDE/ATA2 Disk Controller.

SCSI Bus Controllers

Complete one copy of this page for each SCSI Bus controller in the Network Server

SCSI Bus Controller Number

SCSI Bus Controller (Brand, Model, SCSI Standard)

               (Brand, Model, Capacity, Speed)

Channel 1,SCSI ID 0 _____
Channel 1,SCSI ID 1 _____
Channel 1,SCSI ID 2 _____
Channel 1,SCSI ID 3 _____
Channel 1,SCSI ID 4 _____
Channel 1,SCSI ID 5 _____
Channel 1,SCSI ID 6 _____
Channel 1,SCSI ID 7 _____
Channel 1,SCSI ID 8 _____
Channel 1,SCSI ID 9 _____
Channel 1,SCSI ID 10_____
Channel 1,SCSI ID 11_____
Channel 1,SCSI ID 12_____
Channel 1,SCSI ID 13_____
Channel 1,SCSI ID 14_____
Channel 1,SCSI ID 15_____

Channel 2,SCSI ID 0 _____
Channel 2,SCSI ID 1 _____
Channel 2,SCSI ID 2 _____
Channel 2,SCSI ID 3 _____
Channel 2,SCSI ID 4 _____
Channel 2,SCSI ID 5 _____
Channel 2,SCSI ID 6 _____
Channel 2,SCSI ID 7 _____
Channel 2,SCSI ID 8 _____
Channel 2,SCSI ID 9 _____
Channel 2,SCSI ID 10_____
Channel 2,SCSI ID 11_____
Channel 2,SCSI ID 12_____
Channel 2,SCSI ID 13_____
Channel 2,SCSI ID 14_____
Channel 2,SCSI ID 15_____

FIGURE 2.4
SCSI Bus Controllers.

FIGURE 2.5
RAID Controllers.

RAID Controllers

Complete one copy of this page for each RAID Controller in the Network Server

RAID Controller Number_____

RAID Controller (Brand, Model, SCSI Standard)_____

(Brand Model, Capacity, Speed, RAID Level)

Channel 1,SCSI ID 0 _____
Channel 1,SCSI ID 1 _____
Channel 1,SCSI ID 2 _____
Channel 1,SCSI ID 3 _____
Channel 1,SCSI ID 4 _____
Channel 1,SCSI ID 5 _____
Channel 1,SCSI ID 6 _____
Channel 1,SCSI ID 7 _____
Channel 1,SCSI ID 8 _____
Channel 1,SCSI ID 9 _____
Channel 1,SCSI ID 10_____
Channel 1,SCSI ID 11_____
Channel 1,SCSI ID 12_____
Channel 1,SCSI ID 13_____
Channel 1,SCSI ID 14_____
Channel 1,SCSI ID 15_____

Channel 2,SCSI ID 0 _____
Channel 2,SCSI ID 1 _____
Channel 2,SCSI ID 2 _____
Channel 2,SCSI ID 3 _____
Channel 2,SCSI ID 4 _____
Channel 2,SCSI ID 5 _____
Channel 2,SCSI ID 6 _____
Channel 2,SCSI ID 7 _____
Channel 2,SCSI ID 8 _____
Channel 2,SCSI ID 9 _____
Channel 2,SCSI ID 10_____
Channel 2,SCSI ID 11_____
Channel 2,SCSI ID 12_____
Channel 2,SCSI ID 13_____
Channel 2,SCSI ID 14_____
Channel 2,SCSI ID 15_____

Verifying Adequate Cooling

The site should have adequate air-conditioning capacity to handle the addition of the network server to be installed. The installation plan should state the heat output of the devices that will be part of the network server installation (chassis, monitor, UPS, and so on). It may be difficult to ascertain the current heat load (measured in British Thermal Units, BTUs) of the room where the network server is to be installed. An adequate indicator of the available cooling capacity of the room where the network server will be installed is the room temperature. If the temperature of the room is more than 72 degrees Fahrenheit without the new network server being installed, it is doubtful that there is adequate cooling for the new network server.

Most network servers use internal fans for cooling. For these fans to work properly and provide adequate cooling there has to be adequate clearance around the server for proper airflow. The documentation of the network server will specify the cooling clearances.

NOTE

Add to Tool Kit A server hardware specialist's tool kit should include a digital thermometer.

Verifying the Uninterruptible Power-Supply Size

The uninterruptible power supply (UPS) should be of adequate size to keep the network server running long enough for it to perform a normal shutdown. This time period is usually 5 to 10 minutes. An undersized UPS will keep the server running only a very short time. An oversized UPS will not only keep the network server operational for a longer period of time during a power backup but will also allow for growth of the network server (adding components to the network server over time).

The UPS should be large enough to support all the components of the network server that are connected to (plugged into) the UPS. The size of a UPS is specified by a volt-amp (VA) rating. The larger the VA rating of the UPS, the longer the UPS can keep the network server running in the event of a power failure. Verify that the UPS is of adequate size to support the network server by completing the "UPS Sizing Worksheet," as shown in Figures 2.6 and 2.7. This worksheet also is available as a Microsoft Word document on the CD-ROM that accompanies this book.

As noted on the worksheet, the total VA rating for all equipment is the *minimum* size for a UPS to support the network server. A UPS with a larger VA rating will keep the network server operating for a longer period of time when there is a power failure. A larger VA rating also allows additional network server components to be added.

Verifying the Network Connection

A server hardware specialist should be able to determine that the network connection for the network server is available and of the correct type and speed. You can test this by using another computer system with the proper network adapter installed to see whether the network connection that will be utilized by the network server is working.

Verifying Hardware Components for the Network Server

The next step for the server hardware specialist is to check the components that will be used to assemble the network server. Some network server vendors do not assemble all the hardware components

NOTE

Add to Tool Kit   A server hardware specialist's tool kit should include a laptop computer with both an Ethernet PC Card and a Token-Ring PC Card. Having the two most common network adapters available for the laptop computer should make the verification that the network connection is functional a trivial matter.

UPS Sizing Worksheet

This worksheet is designed to aid in the sizing of an uninterruptable power supply (UPS) to meet the needs of a network server. UPSs are measured in terms of VA (volts-amps). List all the equipment that will be protected by the UPS (that is, all equipment that will be plugged into the UPS). Use Table 1 to list equipment that has voltage and amperage listed. Use Table 2 to list all the equipment that has power consumption listed in watts. Add all numbers in the VA columns of both Table 1 and Table 2. The total VA rating is the *minimum* size to select for the UPS that will support the network server.

In the following table, list all the equipment that has voltage and amperage ratings listed. Multiply voltage times amperage to get the VA rating.

Table 1

Equipment	Voltage (110/220)	Amperage	VA (Volts x Amps)

In the following table, list all the equipment that has wattage ratings listed. Multiply watts times 1.5 to get the VA rating estimate.

Table 2

Equipment	Wattage	VA (Watts x 1.5)

Total VA requirements of all network server equipment to be attached to the UPS:_____

for a network server when they are ordered. The server hardware specialist must be able to take all the components and assemble them into a working network server.

Server Chassis

Verify that the server chassis is the correct model that was ordered and the correct form factor. Most server chassises are either of a tower configuration, a wide- or "fat-" tower configuration, or a rack-mount configuration. Make sure that if you ordered model *X* in a tower configuration, that indeed Model *X* in a tower configuration is delivered, and not Model *X* in a rack-mount configuration (see Figures 2.8, 2.9, and 2.10).

Server Rack

A rack-mount server chassis must be mounted in an equipment rack designed for rack-mounted hardware. Most server vendors that sell servers in a rack-mount chassis also sell the server rack. Server racks generally come in several sizes (heights). Server rack size is measured in rack units (U). A standard rack unit is 1.75 inches. A new network server will either be installed in an existing server rack or a new server rack will be purchased for the new network server. Server racks generally have both front and rear doors and side panels to form a completely enclosed unit. The doors and side panels help form both a secure environment and also are designed to aid in cooling the equipment in the rack by controlling airflow patterns. In most cases, multiple server racks can be joined together to form an installation space for a large number of servers. Figure 2.11 shows an example of a server rack.

A rack-mounted server installation conserves space in the room where the servers reside. If you go with a rack-mounted configuration, however, generally all equipment must be designed to fit into a server rack. This includes the UPS, the keyboard/mouse, and the monitor (either LCD or CRT) for the server. The equipment installation in the server rack should be done to the server vendor's specifications. Several server vendors offer software to aid in the proper placement of the equipment into the server rack. For example, all server vendors recommend that the UPS be installed on the bottom of the rack. This is done for several reasons, including the weight of the rack-mount UPS and the need to avoid the possible damage to a network server caused by a leaking UPS battery.

NOTE **Wide-Tower to Rack-Mount Conversion**
Some wide-tower server chassises can be easily converted to a rack-mount configuration with the purchase of a special rack-mount adapter kit from the server manufacturer.
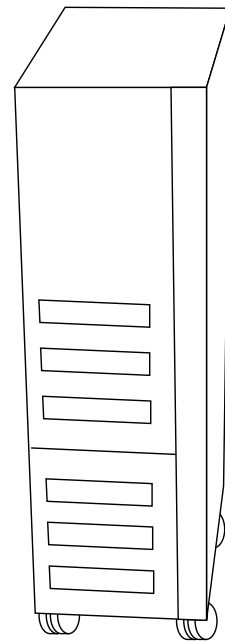

FIGURE 2.8
Server tower chassis.

NOTE **Do Not Move a Loaded Server Rack**
Never attempt to move a server rack that has equipment installed in it. A fully loaded server rack might well weigh in excess of 1,000 pounds. Remove all of the equipment first, then relocate the server rack, lastly reinstall the equipment removed from the server rack.
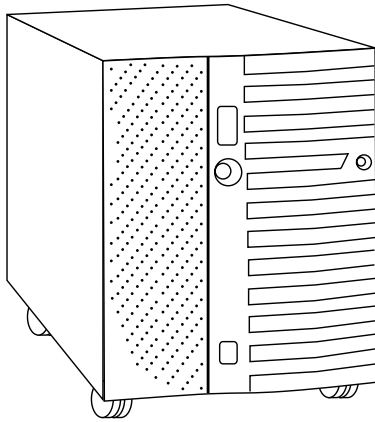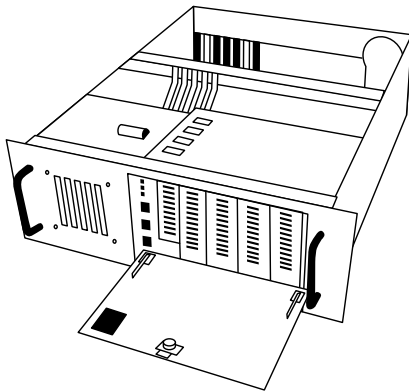
Processor(s)

Network servers commonly have more than one processor. Verify that the correct number and type of processors are available for the network server. Some server vendors install all the processors that were ordered; other server vendors supply the server with zero or one processor installed, and the server hardware specialist must install any additional processors. Verify that the processors are of the same type, speed, and stepping (version). Also verify that each processor has the same size of L2 cache. Follow the network server vendor's instructions for installing additional processors.

Memory

Network servers generally require a considerable amount of memory for them to adequately perform their function. Some server vendors install all the memory that was ordered; however, other server vendors supply the server with a "standard" amount of memory, and the server hardware specialist must install the memory above the standard amount. Verify that the server has the amount of memory that was ordered. If some of the memory must be installed, verify that the memory is the correct type for the server and follow the server hardware vendor's instructions for installation of the additional memory. This is a critical step. Some servers require that memory be installed in groups of 2 or 4 memory modules. (Check the server vendor's documentation to see whether memory modules must be installed in groups of 2 or 4, instead of singly.) Failure to install the memory correctly will result in the server either not recognizing all the memory installed or the server failing to start at all.

Disk Drives

Many network server configurations require that a large amount of disk storage be available in the server. Verify that the disk drives are the correct size, speed, and type (IDE/ATA, EIDE/ATA-2, SCSI, SCSI-2, SCSI-3). The disk drives may come installed in the server chassis or they might be shipped in separate cushioned boxes to avoid damage. The installation plan will specify which disk drives (size, speed, and type) should be installed in the network server.

Monitor

Verify that the monitor for the network server is as ordered. In general the monitor should support VGA resolution of at least 1024 × 768 dots per inch. The monitor can be the traditional CRT type or one of the newer LCD flat-panel monitors. If the monitor is to be rack mounted, a special monitor shelf will need to be purchased. Special rack-mounted LCD flat-panel monitors are available; these often include a keyboard/trackball combination in a single rack drawer.

Keyboard

Verify that there is a keyboard for the server. There are no special requirements for the keyboard that will be used with a server. A rack-mounted keyboard is available for rack-mounted server installations. This rack-mounted keyboard often includes a built-in trackball or touch pad to substitute for a mouse.

Mouse

Verify that there is a mouse for the server. There are no special requirements for the mouse that will be used with a server. The mouse might require a serial connection, a Universal Serial Bus (USB) connection, or a PS/2-type mini-DIN connection. Verify that the type of connection required by the mouse is available on the network server. In a rack-mounted configuration, the mouse is often replaced by a trackball or touch pad built in to the rack-mounted keyboard.

Uninterruptible Power Supply

Verify that a UPS is available for the network server. The UPS should be of adequate size to support the network server for a short period of time, which will allow a graceful shutdown of the server. Rack-mounted UPSs are available for rack-mounted network server installations. All UPSs should be capable of being monitored by the network server, usually through a serial communications cable. If the UPS is to be monitored via the serial connection, make sure that a serial connection is available on the network server. Through the purchase of additional hardware for the UPS, you can usually monitor a UPS through the network. Top-of-the-line UPSs often enable you to monitor them via an SNMP management console or a built-in Web interface.
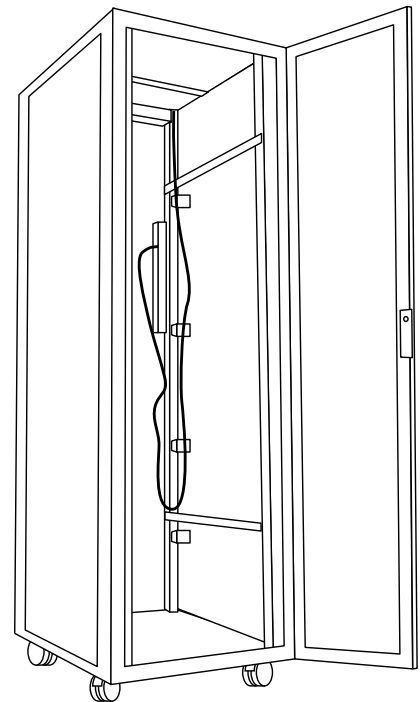

FIGURE 2.11
A server rack.

Backup System

Verify that the backup system is as specified in the installation plan and that it is adequate to support the backup of the network server. The backup system is generally a magnetic tape drive of one form or another. The tape drive should be capable of backing up the contents of the disk drives on the network server in a timely manner. The capacity of the tape drive and the speed that data can be transferred to the tape drive are both of critical importance. If you determine that given the specifications of the tape drive, a full backup of the network server would take 10 hours and you only have 4 hours to perform the backup, for example, the tape drive is inadequate for the job. You also can back up other devices, such as hard disk drives, CD-R devices, and CD-RW devices. See Chapter 1 for a complete discussion of backup systems.

The backup devices should be installed on a separate controller from the disk drives of the network server, to provide peak performance during the backup process.

SCSI Cables

Verify that the correct cables have been delivered to connect the SCSI channel controller to the SCSI devices (disk drives). SCSI cables differ distinctly from each other (for example, SCSI-1, SCSI-2, and SCSI-3). The wide versions of SCSI-2 and SCSI-3 utilize different cables. Internal SCSI cables are generally ribbon cables, with pin 1 identified by a colored (usually red) strip on the edge of the ribbon cable. External SCSI cables are generally in a round bundle. Verify that the SCSI cables have the correct number of connectors for the network server configuration.

Make sure that the SCSI cables do not exceed the SCSI channel length maximums. Also make sure that the SCSI cables have enough connectors to allow all the SCSI devices to be attached. If you need to attach four SCSI disk drives to a SCSI channel, for example, the SCSI cable needs at least four connectors for the disk drives, plus one where it can be attached to the SCSI adapter.

SCSI Adapter(s)

Verify that the correct SCSI adapter is available. Many network servers have one or more SCSI adapters built in. Additional SCSI adapters may be required to support the number of SCSI devices that will used with the network server. Make sure that the SCSI adapter and SCSI devices are of the same type of SCSI (SCSI-1, SCSI-2, SCSI-3, and so forth). Make sure that the SCSI adapter's interface matches the bus that is in the network server for example, EISA, PCI, or PCI-64.

RAID Controller(s)

If the network server is going to use the hardware version of RAID, verify that the RAID controller is available. The RAID controller should be delivered with configuration software. The RAID controller must be configured before the network operating system can be installed. Most RAID controllers are designed to support some version of SCSI disk drives. Make sure that the RAID controller matches the bus that is in the network server for example, EISA, PCI, or PCI-64.

Fibre Channel—Arbitrated Loop Host Bus Adapter

If the network server is going to be using Fibre Channel—Arbitrated Loop (FC-AL) disk systems, verify that the correct Fibre Channel host bus adapter (HBA) has been delivered. Fibre Channel may use either fiber-optic cable or copper wire for the connection media. Make sure that the HBA has the correct connection (fiber optic or copper) and that the correct cables are included. The vast majority of FC-AL installations have the disk system external to the network server chassis. Chapter 3, "2.0—Configuration," covers the connection of FC-AL external devices.

Network Interface Card(s)

Verify that the network interface card (NIC) for the network server is available. Some network servers have the NIC built in to the network server. If redundant NICs are required for the network server, verify

that all NICs are available. Make sure that the NIC supports the type of network where the network server is going to be installed (Ethernet, Token Ring, and so on). Multiple NICs might also be installed in a single network server if it is to be attached to multiple networks.

Miscellaneous Hardware

Other hardware might be required for the network server. The network server does require a video adapter to support the network server monitor. There is no reason to spent lots of money getting a fancy video adapter that has a large amount of video memory to support extremely high video resolution and billions of colors. The video monitor on a network server is generally utilized only to perform administrative functions on the network server. A video adapter that can support VGA resolution of up to 1024×768 and 65,536 colors should be adequate for most network servers.

Many server hardware vendors have a specialized server management adapter that can be purchased and installed in their network servers. These devices generally monitor the health of the server hardware and can be used by server management software running on a designed management computer. Some of these devices have a built-in modem, which will allow monitoring of the server hardware via a dial-in connection.

A rack-mounted network server might include a keyboard/video/ mouse (KVM) switch to allow one keyboard, one video display, and one mouse to be utilized by multiple network servers that are in a single rack. The KVM switch allows the keyboard, mouse and video display to switch (usually from the keyboard) among the network servers in the rack. This saves space in the rack, because each network server will not require its own keyboard, mouse, and monitor. Some cost savings also is associated with sharing the keyboard, mouse, and monitor, because you don't have to buy them for each server.

A network server also should have some devices commonly found on most desktop computer systems, such as a 3.5-inch floppy disk drive and a CD-ROM drive or a DVD-ROM drive. These devices are required to install operating system software, hardware drivers, and other software onto the network server.

INSTALLING HARDWARE

▶ 1.2 Install hardware using ESD best practices (boards, drives, memory, internal cables, etc.) These activities include:

- Mount the rack installation

- Cut and crimp network cabling

- Install Uninterruptible Power Supply

- Verify SCSI ID configuration and termination

- Install external devices (e.g., keyboards, monitors, subsystems, modem rack, etc.)

- Verify power-on via power-on sequence

Once the server hardware specialist has verified all the hardware for the network server, the next step is the actual installation of the hardware.

Electrostatic Discharge

Electrostatic discharge, better known as ESD, is a build up of electric charges on a body that can be transferred to another body upon contact. This buildup of electric charge can easily damage the sensitive components found inside a network server. While installing components inside of a server chassis, it is very important that you do not accidentally build up an electric charge that can be transferred to components inside the network server. You should follow the list of ESD Best Practices included here anytime that you open the chassis of the network server (to install, upgrade, or maintain components in the chassis).

ESD can be caused by any of the following:

◆ People moving around (especially on carpet)

◆ Low humidity

◆ Unshielded cables

◆ Improper grounding

ESD Best Practices

While working on a network server, follow this list of the best practices to ensure that you do not have a problem with ESD:

◆ Always use a static discharge device (static wrist strap, antistatic mat) when you open the server chassis to access components in the server.

◆ Always store components in static bags until you are ready to use them.

◆ Before you touch anything inside a network server, touch the housing of the power supply. This will discharge any static charge that may have built up on your body.

◆ Use antistatic solutions on carpets in the server room.

◆ Use a room humidifier if the humidity is constantly below 50%.

◆ If possible, install antistatic carpet in the server room.

◆ Hold disk drives by the edges. Do not touch the circuit board on the bottom of the disk drive.

Installing Processors

If you must install additional processors in a network server, be sure that you follow the ESD best practices. Always follow the server hardware vendor's installation instructions. You must check several factors about additional processors before installing the additional processors.

Match Processor Speed

The clock speed of the processors in a network server must be the same.

Match Processor Cache Size

The size of the processor cache for all the processors in a network server must be the same. Processors generally have cache sizes of 256KB, 512KB, 1024KB (1MB), and 2048KB (2MB). Mixing processors with caches of different sizes will not work at all in some network servers, and will affect performance in the network servers that do allow mixing of processor cache sizes. It is best *not* to mix processor cache sizes, even though some network server manufacturers do support mixed cache sizes.

Match Processor Stepping (Version)

A *stepping* is the Intel term used to describe different versions of a given processor. Intel recommends that processors in a multi-processor server should have steppings that differ by no more than one. Intel refers to this as (N+1) stepping. It is best that the processors have the same identical stepping number.

For more information about steppings, see Intel's Web site at `www.intel.com/newsgroups/mips/mip_2.htm#five`.

EXAM TIP

Stepping   Know that multiple processors in a network server must meet the (N+1) stepping requirements.

Buses

The server hardware specialist does not install the buses in the network server, but needs to be aware of the buses that are in the network server to install additional adapters in the network server. Most servers have one or more PCI or PCI-64 buses. The multiple buses allow the server to transport more data between the NICs and the network server or the SCSI controller and the network server. The PCI bus is 32–bits wide, which means that it can transfer 4 characters or bytes of data per clock cycle. (32 bits divided by 8 bits per byte equals 4 bytes.) The PCI-64 bus is 64-bits wide, which means that it can transfer 8 characters of data per clock cycle. The PCI and PCI-64 buses operate at 33 Megahertz. This means that a PCI bus has a maximum theoretical transfer rate of 32MBps (33 million hertz × 4 bytes/second). A PCI-64 bus has a maximum theoretical transfer rate of 264MBps (33 million hertz × 8 bytes/second). Some newer PCI buses operate at 66 Megahertz, thus doubling the transfer rate. The trade-off for this faster bus speed is usually fewer connections available on the bus. PCI buses that operate at 100MHz will soon be available.

Peer Buses

A network server with peer buses has multiple buses that act independently. Most peer bus systems are dual peer (two buses) or triple peer (three buses). This means that each bus has the full transfer rate available. On a server that will be transferring large amounts of data to and from the disk drives, as well as transferring large amounts of data to and from the network, can have this workload balanced between the peer buses. You just place the disk controller on one bus and the NIC on the other bus. Figure 2.12 shows a diagram of a peer bus.
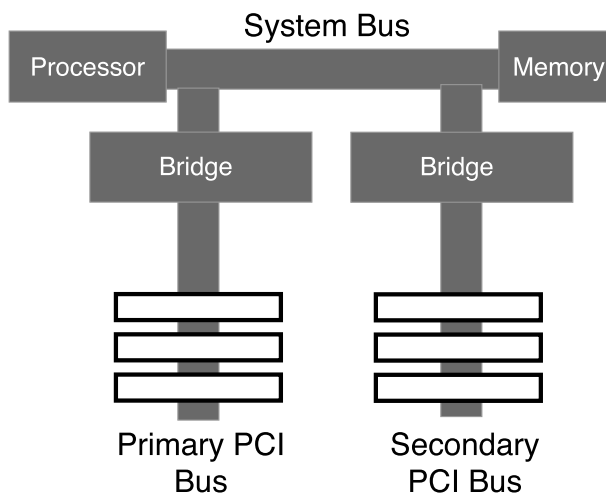
Dual-Peer PCI Buses

A dual-peer PCI bus provides two separate buses that can each operate at full speed, effectively doubling data transfer capacity. To take advantage of the two buses, install adapters that require high data-transfer capability on separate buses. (For instance, put a 100BASE-T network adapter on one bus and put a SCSI controller on the other bus.)

Bridged Buses

A server with bridged buses has multiple buses that act as one. This is done to increase the number of PCI slots available on a server. Both buses share the available transfer speed. Placing the disk controller on one bus and the NIC on the other bus has no load balancing benefit because the buses are essentially one. Figure 2.13 shows a diagram of a bridged PCI bus.

Memory Installation

If you must install additional memory into the network server, be sure that you follow the ESD best practices listed earlier in this chapter. Always follow the server hardware vendor's installation
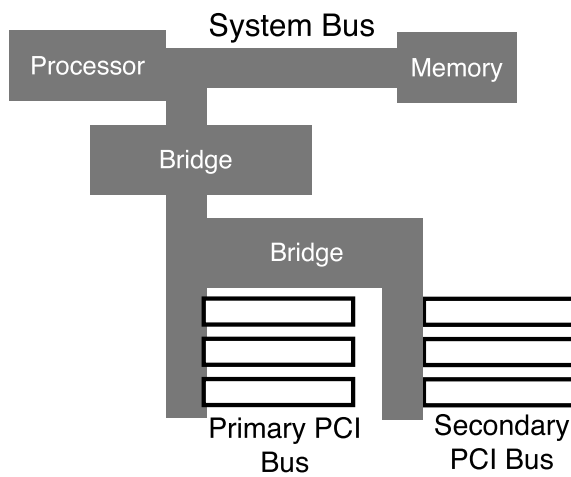
> **EXAM TIP**
>
> **Buses**   Know the difference between a peer bus and a bridged bus.

System Bus

Processor

Memory

Bridge

Bridge

Primary PCI
Bus

Secondary
PCI Bus

Bridged PCI Buses

instructions. Again, some servers require that memory be installed in groups of 2 or 4 memory modules. You must check several factors about additional memory before installing the additional memory.

Match Memory Type

The memory type must meet the requirement of the network server hardware. You cannot mix types of memory in a server, even if the memory can be physically installed into the server. Check the memory type required by the network server hardware and make sure that all memory to be installed into the network server is of the correct type. Chapter 1 fully describes the different types of memory.

Match Memory Speed

The memory speed must be the same for all the memory in the network server. Check the memory speed required by the network server hardware and make sure that all memory to be installed into the network server is the same speed. Chapter 1 fully describes memory speed.

Disk Subsystem Installation

The installation process of the disk subsystem for the network server will vary greatly depending on the type and number of disk drives to be installed. Be sure to use ESD best practices when installing disk subsystem components. Most server hardware uses SCSI disk drives for their speed and the number of disk that you can attach to a single SCSI controller. IDE or EIDE disks are seldom used in servers due to the load that they put on the processor and the limited number of disk drives that can be installed on a single disk controller (2 disks per channel, 2 channels per controller). IDE and EIDE disk controllers are also limited to disk drives that are internal to the network server. (No external connections allowed.) SCSI can support both internal and external disk drives. Most RAID controllers are also SCSI controllers; therefore the same installation rules for SCSI apply for SCSI-based RAID. Chapter 1 fully discusses disk subsystems.

IDE/ATA Disks

IDE disk drives and controllers (also known as *ATA disk drives* and *controllers*) are limited to two channels with a maximum of 2 disk drives per channel. The IDE/ATA channel is a 40-conductor ribbon cable that is a maximum of 18 inches long. The short channel length limits IDE/ATA to devices that are internal to the network server. That is a total of 4 disk drives per IDE/ATA disk controller. These disk controllers rely on the processor of the computer to perform most of the disk input/output operations.

Each disk drive that is attached to an IDE/ATA disk controller must have a jumper set on the back of the disk drive to specify the role the disk will perform in relationship to the other disk on the same channel. A single IDE disk is usually set to the master role. If a second IDE disk is attached to the same channel as an existing IDE disk drive that is set to Master, it *must* be set to the slave role. In essence, the disk hardware on the Master disk drive controls both the Master and Slave disk drives. A third option called *Cable Select* (CSEL) will allow the IDE adapter to select which IDE disk drive will function as Master and which IDE disk drive will function as Slave. If both IDE disk drives that are on a single channel are set to Master, or if both are set to Slave, the disk subsystem will not work. No industry standard applies to the jumper settings for IDE disk drives, so read your drive documentation carefully. Figure 2.14 shows a diagram of the selections available for a typical IDE disk drive.
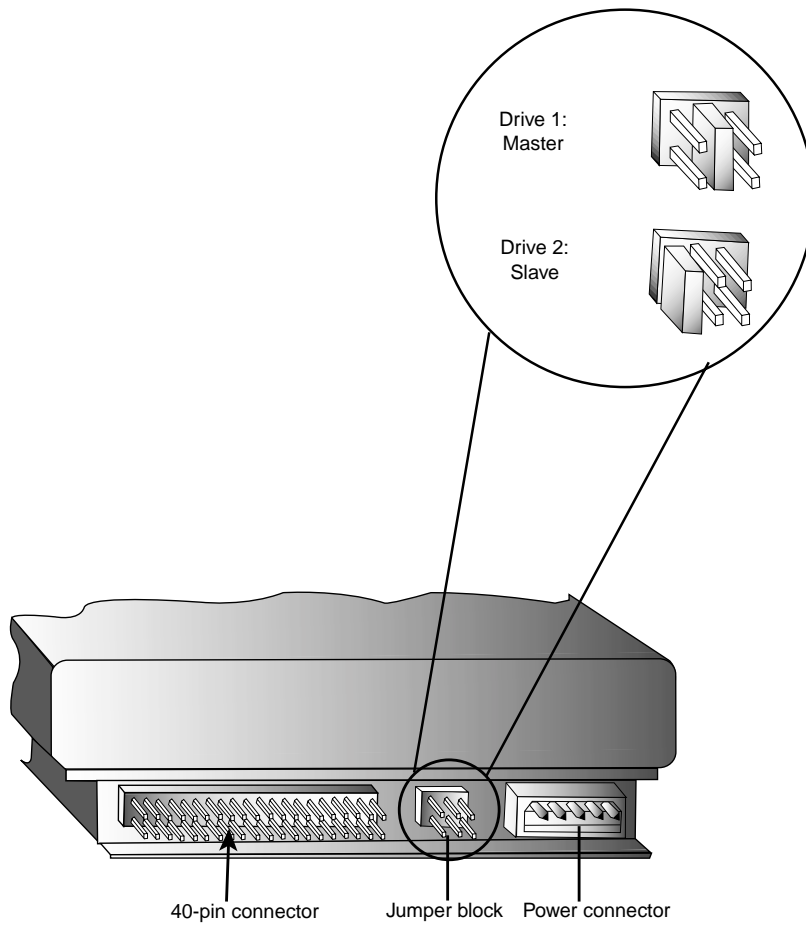
Drive 1:
Master

Drive 2:
Slave

40-pin connector   Jumper block   Power connector

EIDE/ATA-2 Disks

Enhanced IDE disk drives (also known as *ATA-2 disk drives*) are an enhancement to the original IDE/ATA disk drive specification and allow for increased performance. The length of the EIDE/ATA-2 channel (ribbon cable) remains at 18 inches.

Each disk drive that is attached to an EIDE/ATA-2 disk controller must have a jumper set on the back of the disk drive to specify the role the disk will perform in relationship to the other disk on the same channel. A single EIDE/ATA-2 disk is usually set to the master role. If a second EIDE/ATA-2 disk is attached to the same channel as an existing EIDE/ATA-2 disk drive that is set to Master, it *must* be set to the slave role. In essence, the disk hardware on the Master disk drive controls both the Master and Slave disk drives. CSEL will allow the EIDE/ATA-2 adapter to select which EIDE/ATA-2 disk

> **N O T E**
>
> **ATA-2/RAID**   At least one manufacturer builds a RAID controller based on an ATA-2 disk controller. However, this ATA-2/RAID controller limits you to using only four disk drives.

drive will function as Master and which EIDE/ATA-2 disk drive will function as Slave. If both EIDE/ATA-2 disk drives that are on a single channel are both set to Master, or are both set to Slave, the disk subsystem will not work.

Ultra ATA/Ultra DMA

Ultra ATA, which is also known as Ultra DMA, disk drives adhere to the ATA-3 specification. These disk drives are typically much faster than the older ATA and ATA-2 disk drives. These disk drives are installed and configured the same way that ATA-2 disk drives are configured (Master/Slave/CSEL). However, the faster versions, ATA-66 and ATA-100, require that a special ribbon cable be used to connect the disk drives to the ATA adapter. This special cable contains 80 conductors, but it still uses the same 40-pin connectors used by earlier ATA disk drives. Failure to use these special cables for these high-speed disks can result in disk system problems and possible data loss.

EXAM TIP

Drives   Know the IDE/ATA/EIDE/ATA-2 Master/Slave/CSEL requirements.

STEP BY STEP

2.1 Installing IDE/ATA/EIDE/ATA-2 Disk Drives

1. Set the Master/Slave/CSEL jumper on each disk drive.

2. Connect IDE/ATA/EIDE/ATA-2 ribbon cable to IDE/ATA/EIDE/ATA-2 disk controller. (Red line on ribbon cable connects to pin 1 on connector on disk controller.)

3. Connect IDE/ATA/EIDE/ATA-2 ribbon cable to IDE/ATA/EIDE/ATA-2 disk drive. (Red line on ribbon cable connects to pin 1 on connector on disk drive.)

4. Connect power cable to each IDE/ATA/EIDE/ATA-2 disk drive.

5. Document all settings.

SCSI Disks

The majority of server hardware will use Small Computer Systems Interface (SCSI) disk drives for a multitude of reasons, including the following:

◆ SCSI is a bus controller (*not* a disk controller).

◆ The SCSI bus controller is an intelligent device that off-loads from the server processor the tasks of accessing the disk subsystem.

◆ SCSI disks are generally very fast compared to other disk drive systems.

◆ A SCSI controller can control up to 7 devices per channel (15 devices on SCSI-3 controllers).

◆ A SCSI controller can have up to 5 channels.

◆ SCSI devices can be internal to the server or external to the server (in a separate enclosure).

◆ You should not run both internal and external devices on the same SCSI channel.

The SCSI bus identifies each device by a SCSI ID number. Most SCSI buses can handle a total of 8 devices per channel, which are numbered from 0 through 7. (Some versions of SCSI support a total of 16 devices per channel, which are numbered 0 through 15.) Each device on a SCSI channel must have a unique SCSI ID. SCSI ID numbers are generally set by jumpers on the SCSI disk drive itself. Duplication of the SCSI IDs on a SCSI channel can cause the channel to be inaccessible. If you want to be able to boot from a SCSI disk drive, give it a SCSI ID of 0 or 1.

Other rules for SCSI are pretty simple. Each end of the SCSI bus must be terminated. Generally the SCSI controller itself is on one end of the SCSI bus and it usually has onboard termination. The other end of the SCSI cable is either terminated by a resistor on the last disk drive on the chain or a physical terminator on the end of the SCSI bus. Figure 2.15 shows an example of SCSI termination.

There are three types of SCSI termination: passive termination, active termination, and forced perfect termination (FPT). Passive termination is cheap to implement, but should be used only for lower speed SCSI channels with relative short cables. Active termination is preferred and can handle much higher speeds and longer cables. Forced perfect termination is the best method and can be used for even the highest speed SCSI implementation. It also is the most complex to implement and therefore the most costly. However, the extra cost will result in a much more reliable SCSI system.

EXAM TIP

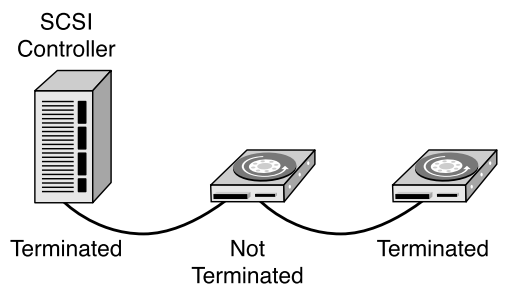**Terminating SCSI**   Know that both ends of a SCSI bus must be terminated.

FIGURE 2.15
SCSI bus termination.

SCSI termination may be implemented in several ways. Because both ends of the SCSI bus must be terminated and because the SCSI adapter is going to be on one end of the SCSI bus, one termination point will be on the SCSI adapter itself. This is usually done automatically and there is no need for additional changes to the SCSI adapter for it to terminate the SCSI bus at one end.

On the other end of the SCSI bus, the last disk drive on the SCSI channel must be terminated (usually done via a jumper on the disk drive or a special terminator inserted on the last connector on the SCSI cable). In fact, it is very common for low-voltage differential SCSI devices to not have the capability to terminate the SCSI bus on the device itself; you must use a special terminator inserted in the last connector on the SCSI cable.

SCSI-1, SCSI-2, and SCSI-3 disk drives can be mixed on the same SCSI channel, but it is not recommended. Mixing disk drives from the different versions of SCSI can seriously impact performance of the SCSI channel.

Chapter 1 includes a detailed discussion of SCSI in all its various forms.

SCSI Disk Types

Three major versions of the SCSI standard are currently on the market. Luckily, they are known as SCSI-1, SCSI-2, and SCSI-3. Installation of SCSI devices among the three different SCSI standards is very similar. The differences are mainly in the size of the SCSI connector that is used to connect the SCSI disk drive to the SCSI cable.

There are also three signaling systems (single-ended [SE], differential [DIFF]—also known as high-voltage differential [HVD]—and low-voltage differential [LVD]) that can be used by SCSI devices. There is no difference in the connectors used among the three different signaling systems. To help identify the signaling system used by SCSI devices (controllers and drives), a system of symbols has been devised to identify the different signaling systems. Look for these symbols on all SCSI devices. Figure 2.16 shows examples of the SCSI symbols.

SCSI-1

Originally just known as SCSI, it was used by many Apple computers in the early 1980s. By today's standards it was rather slow. The SCSI bus ran at 5MHz using an 8-bit data path. This allowed a data transfer rate of 5MB per second.

SCSI-1 generally supported a single channel per SCSI controller. The SCSI-2 internal cable was a ribbon cable that was attached to the disk controller by a 50-pin connector. Many early SCSI controllers used a DB-25, 25-pin connector for external SCSI devices. The termination for the SCSI-1 was usually a set of 3 resistors on the SCSI controller (assuming it was at the end of the SCSI bus) or a set of three resistors on the last SCSI disk drive on the bus, or an actual terminator attached to the end of the SCSI bus. Maximum cable length of SCSI-1 is 6 meters.

WARNING

Differential Danger   Attaching a device using the differential (HVD) signaling method can seriously damage devices designed to use the single-ended or low-voltage differential signaling systems.
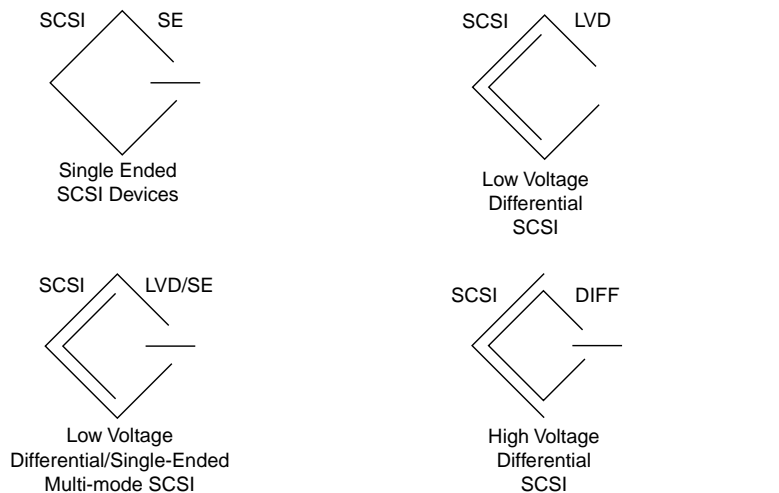
SCSI-2

SCSI-2 uses two different signaling systems, known as single-ended interface and differential interface. The two signaling systems are incompatible and cannot be mixed on the same SCSI bus. Make sure that all devices, including the SCSI-2 controller, are all using either single-ended interface or all using the differential interface. Due to bus length restrictions, single-ended SCSI-2 cabling is usually found inside a server chassis. The differential interface allows for longer cable lengths and is generally found connecting the server to an external SCSI device. SCSI-2 uses the same 50-pin connector on the internal SCSI cable that is used by SCSI-1 devices.

However, SCSI-2 also has a variant called Wide SCSI-2, which can transfer 16 bits at a time as opposed to the 8 bits at a time used by normal SCSI-1 and normal SCSI-2. This extra bus width requires the use of a 68-pin connector. Wide SCSI-2 allows for 16 devices on the SCSI-2 channel, whereas normal SCSI-2 (also called narrow SCSI-2) and SCSI-1 only allow 8 devices on the SCSI channel.

SCSI ╱╲ SE

Single Ended
SCSI Devices

SCSI ╱╲ LVD

Low Voltage
Differential
SCSI

SCSI ╱╲ LVD/SE

Low Voltage
Differential/Single-Ended
Multi-mode SCSI

SCSI ╱╲ DIFF

High Voltage
Differential
SCSI

FIGURE 2.16
SCSI symbols.

Another variant of SCSI-2 is Fast SCSI-2, which doubles the bus speed from 5MHz to 10MHz. Fast SCSI-2 requires an active termination technique. Due to the increased speed, the bus length is reduced from 6 meters to 3 meters.

And, of course, there also is a Fast-Wide SCSI-2 implementation. It requires 68-pin cables, active termination, and short cable length (3 meters), but it can transfer data at 20MBps.

SCSI-2 (Narrow SCSI-2) uses 50-pin connectors on the internal SCSI-2 devices. Wide SCSI-2 uses 68-pin connectors on the internal SCSI-2 devices. Figures 2.17, 2.18, and 2.19 show examples of 50-pin, 68-pin, and 80-pin (SCA) connectors respectively. The Fast SCSI-2 and Fast-Wide SCSI-2 variants require active termination. Regular SCSI-2 and Wide SCSI-2 can use passive termination, although active termination is preferred.

The SCSI 80-pin connector is a special connector that is often used by server hardware OEMs. The 80-pin connector is a single connector that combines the functions of a normal SCSI connector, a power connector, and the SCSI ID's jumpers into one connector. This makes the installation of hot-swappable disk drives very easy. The single 80-pin SCA connector provides power to the disk drive, provides all SCSI control functions, and sets the SCSI ID of the disk drive (usually based on the position of the drive in the chassis).

EXAM TIP

Know Your Connectors   Be able to identify 50-pin, 68-pin, and 80-pin SCSI connectors.
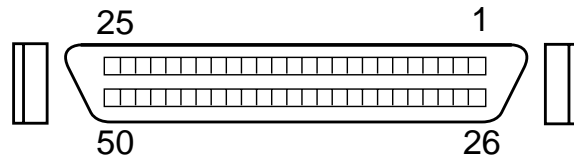
FIGURE 2.17
50-pin SCSI connector.

FIGURE 2.18
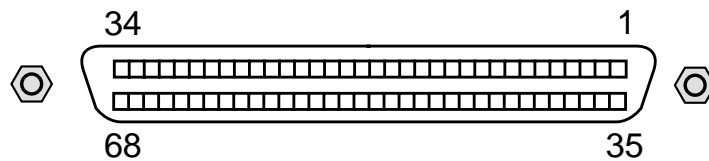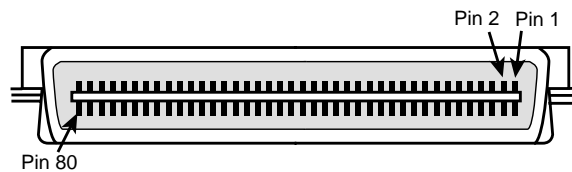68-pin SCSI connector.

FIGURE 2.19
80-pin or SCA SCSI connector.

SCSI-3

SCSI-3 is the latest standard of the SCSI family. It combines all the best features of the previous SCSI standards. It uses LVD, which uses differential signaling, and supports up to 15 devices on a single cable, which can be up to 12 meters long. SCSI-3 supports three different bus speeds, known as Ultra (20MHz), Ultra2 (40MHz), and Ultra3 (double-clocked 40MHz). There are both narrow (8-bit) and wide (16-bit) implementations of the three SCSI-3 bus speeds.

Ultra SCSI-3 and Ultra2 SCSI-3 both use 50-pin connectors. The wide variants (Wide Ultra SCSI-3 and Wide Ultra2 SCSI-3) as well as Ultra3 (also known as Ultra160 SCSI-3) use 68-pin connectors. All versions of SCSI-3 require active termination. Table 2.1 summarizes the maximum cable lengths for various types of SCSI.

TABLE 2.1

Maximum SCSI Bus Length by Type

Type of SCSI	Length
Standard	6 meters
Fast	3 meters
Wide-Ultra	1.5 meters
Low-voltage differential	12 meters
Differential	25 meters

Installing SCSI

Step-by-Step 2.2 walks you through the process of installing SCSI components.

STEP BY STEP

2.2 Installing SCSI Components

1. Set the SCSI IDs on the disk drives (see Table 2.2).

2. Insert SCSI controller into the server.

3. Install SCSI disk drives into the server.

continues

continued

4. Connect the SCSI ribbon cable to SCSI controller. (Red strip on the ribbon cable should be attached to pin 1 on the SCSI controller.)

5. Connect the SCSI ribbon cable to SCSI disk drives. (Red strip on the ribbon cable should be attached to pin 1 on the SCSI connector on the disk drive.)

6. Terminate both ends of the SCSI bus.

7. Connect the power connector to the SCSI disk drives.

8. Document all settings.

Table 2.2 shows the various jumper settings for setting the SCSI ID on SCSI devices.

TABLE 2.2

SCSI ADDRESS JUMPER SETTINGS

SCSI ID	Jumper 4	Jumper 3	Jumper 2	Jumper 1
0	OFF	OFF	OFF	OFF
1	OFF	OFF	OFF	ON
2	OFF	OFF	ON	OFF
3	OFF	OFF	ON	ON
4	OFF	ON	OFF	OFF
5	OFF	ON	OFF	ON
6	OFF	ON	ON	OFF
7	OFF	ON	ON	ON
8	ON	OFF	OFF	OFF
9	ON	OFF	OFF	ON
10	ON	OFF	ON	OFF
11	ON	OFF	ON	ON
12	ON	ON	OFF	OFF
13	ON	ON	OFF	ON
14	ON	ON	ON	OFF
15	ON	ON	ON	ON

Only Wide SCSI devices have 4 jumpers. All other SCSI devices have 3 jumpers. Notice that if you substitute the numeral 1 for all the ON settings and the numeral 0 for all the OFF settings, you are counting from 0 to 15 in binary.

Fibre Channel Arbitrated Loop

If the network server is going to be attached to an external Fibre Channel Arbitrated Loop disk system, insert the FC-AL HBA into an available slot on the network server bus. The disk system to be attached to the FC-AL HBA is generally external to the network server chassis. The connectors on the FC-AL can be either fiber-optic or copper wire. Check that the correct external cable is available. Chapter 3 discusses FC-AL in more detail.

Network Subsystem Installation

Many network servers come with a built-in NIC. Other vendors install the NIC in an available slot on the PCI bus in the server. In either case, the NIC must match the network to which the server is going to be attached (Ethernet or Token Ring).

Ethernet

The vast majority of networks today are based on a version of Ethernet. The two most common types of Ethernet are known as 10BASE-T and 100BASE-T. 10BASE-T Ethernet operates at 10Mbps. 100BASE-T Ethernet operates at 100Mbps and is known as Fast Ethernet. 1000BASE-T is becoming available and operates at 1Gbps (1000 megabits per second) and is known as Gigabit Ethernet. Luckily 10BASE-T and 100BASE-T use the same type of network cabling, unshielded twisted-pair (UTP). The connector on the end of the UTP is known as an RJ-45 connector. The twisted-pair cable contains 4 pairs of 2 wires each that are twisted around each other. One end of the UTP cable plugs into an RJ-45 jack on the back of the NIC in the server. The other end of the UTP cable plugs into a network device (either a hub or a switch). The maximum distance from the hub or switch to the NIC is 100 meters. Figure 2.20 shows an example of an Ethernet connection.
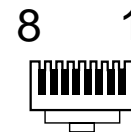

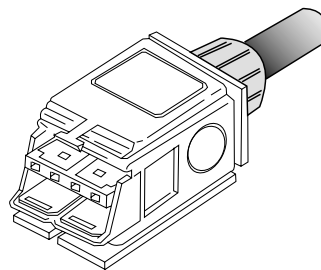**FIGURE 2.20**
Ethernet RJ-45 connector.

Token Ring

Token-Ring networks can use either the same type of cable that is used by Ethernet network (UTP) or a more expensive type of cable known as shielded twisted-pair (STP). If UTP cable is used, the cable plugs into an RJ-45 jack on the back of the NIC in the server. The other end of the cable is plugged into an RJ-45 connector on a device known as a multi-station access unit (MSAU). If STP cable is used, the cable plugs into a DB-9 connector on the back of the NIC (only 4 pins are used). The other end of the STP cable has an IBM Universal Data Connector on it that plugs into an MSAU. The distance from the NIC to the MSAU in either case is limited to 100 meters. Token Ring operates at either 4Mbps or 16Mbps. Figure 2.21 shows an example of a Token-Ring connection.

Network Interface Cards

A network server can have multiple NICs. These can be used to attach the network server to multiple networks, which can be the same type or different types (for instance, both Ethernet, both Token Ring, or one Ethernet and the other Token Ring). Multiple NICs also can be used to provide fault tolerance. (For instance, if one NIC fails the other NIC takes over.) Multiple NICs also can be used together to provide more network throughput to the server. (For instance, four 100Mbps NICs in one server used together would provide 400Mbps throughput to the server.)

Network Cabling

Most networks today are built using UTP cable. The connector on the end of the cable is known as an RJ-45 connector. UTP cable has a total of 8 wires in it (4 pairs of 2 wires each). The RJ-45 connector terminates all 8 wires in a clear plastic connector. The 8 wires are

Token Ring Universal Data Connector
[Connects to MultiStation Access Unit (MSAU)]
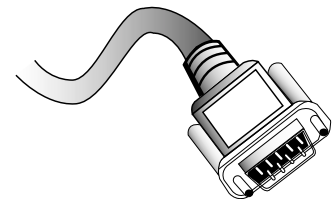
Token Ring DB-9 Connector
(Connects to Network Interface Card)

FIGURE 2.21
Connectors for Token-Ring network cable.

color coded to allow them to be placed in the correct order when the UTP cable is terminated. A crimping tool is used to terminate a UTP cable in an RJ-45 connector. Figure 2.22 shows a crimping tool.
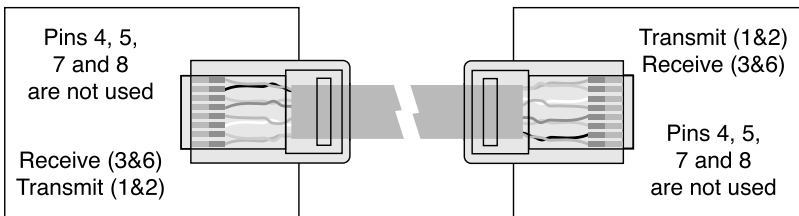
NIC to Hub

The cable used to connect an Ethernet NIC to an Ethernet hub (or switch) is called a straight-through cable. The 8 wires are in the same order (1–8) at each end of the cable. This is the most common type of Ethernet cable. It also is sometimes called a *patch cable*. Figure 2.23 shows an example of wiring a straight-through UTP cable.

Hub to Hub

If you need to connect two Ethernet hubs together in a network, you have two choices. If the Ethernet hub has a special RJ-45 jack known as an *uplink port* (also sometimes labeled *MDI-X*), you can use a standard Ethernet straight-through UTP cable. This is just like the cable normally used to attach an Ethernet NIC to an Ethernet hub.

The other choice comes into play when the Ethernet hubs do not have an uplink port. You can connect two Ethernet hubs together by using a special UTP cable known as a *crossover-cable*. In a cross-over cable, the 8 wires in the UTP cable are wired differently. In a cross-over cable, wire 1 goes to wire 3 on the other end, wire 2 goes to wire 6 on the other end. Wires 4, 5, 7, and 8 go straight through. Figure 2.24 shows an example of a cross-over cable.
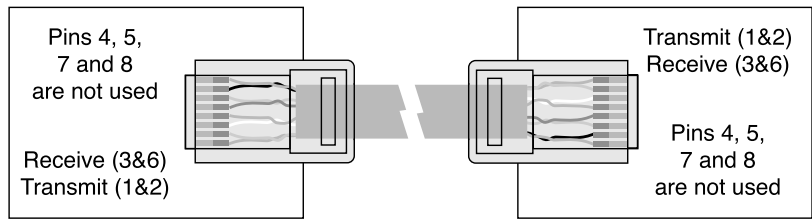

FIGURE 2.22
A UTP crimping tool.

> **NOTE**
>
> **Add to Tool Kit** A server hardware specialist's tool kit should include a supply of RJ-45 connectors and a crimping tool.

> **EXAM TIP**
>
> **Ethernet Wiring** Know the wiring for an Ethernet UTP straight-through cable.

> **NOTE**
>
> **Add to Tool Kit** A server hardware specialist's tool kit should include a 10-foot straight-through cable.

Pins 4, 5, 7 and 8 are not used		Transmit (1&2) Receive (3&6)
Receive (3&6) Transmit (1&2)		Pins 4, 5, 7 and 8 are not used

Pin number	Wire color	Straight-Through	Pin number	Wire color
Pin 1 →	Orange/White		Pin 1 →	Orange/White
Pin 2 →	Orange	Wire Becomes	Pin 2 →	Orange
Pin 3 →	Green/White		Pin 3 →	Green/White
Pin 4 →	Blue	1 → 1	Pin 4 →	Blue
Pin 5 →	Blue/White	2 → 2	Pin 5 →	Blue/White
Pin 6 →	Green	3 → 3	Pin 6 →	Green
Pin 7 →	Brown/White	6 → 6	Pin 7 →	Brown/White
Pin 8 →	Brown		Pin 8 →	Brown

FIGURE 2.23
Ethernet RJ-45 straight-through cable.

FIGURE 2.24
Ethernet RJ-45 cross-over cable.

| Pins 4, 5, 7 and 8 are not used | | Transmit (1&2) Receive (3&6) |
| Receive (3&6) Transmit (1&2) | | Pins 4, 5, 7 and 8 are not used |

Pin number Wire color	Crossed-Over	Pin number Wire color
Pin 1 → Orange/White		Pin 1 → Orange/White
Pin 2 → Orange	Wire Becomes	Pin 2 → Orange
Pin 3 → Green/White		Pin 3 → Green/White
Pin 4 → Blue	1 → 3	Pin 4 → Blue
Pin 5 → Blue/White	2 → 6	Pin 5 → Blue/White
Pin 6 → Green	3 → 1	Pin 6 → Green
Pin 7 → Brown/White	6 → 2	Pin 7 → Brown/White
Pin 8 → Brown		Pin 8 → Brown

EXAM TIP

More Ethernet Wiring   Know the wiring for an Ethernet UTP cross-over cable.

NOTE

Add to Tool Kit   A server hardware specialist's tool kit should include a 10-foot cross-over cable.

NOTE

NIC to NIC   You also can use a cross-over cable to connect two NICs together to form a two-computer network without a hub in between them.

Backup System Hardware Installation

The backup system hardware is generally a tape drive of some sort. For top performance, the tape drive should have a SCSI interface. The tape drive should be connected to a SCSI controller that is different from the SCSI controller that has the hard disk drives that you are going to back up to the tape drive. This provides the best backup performance. Tape drives can be internal to the server chassis or external in a different cabinet.

Uninterruptible Power-Supply Installation

The UPS is always a device that is external to the server itself. The UPS is plugged directly into the power source. The server and its components are then plugged into the UPS. A serial or USB cable that runs from the UPS to a port on the server gives the network operating system the capability to monitor the UPS, so that it will know when the power has failed and the UPS is providing power via batteries. A rack-mounted UPS is generally installed as the lowest device in the rack. Figure 2.25 shows a diagram of UPS cabling.
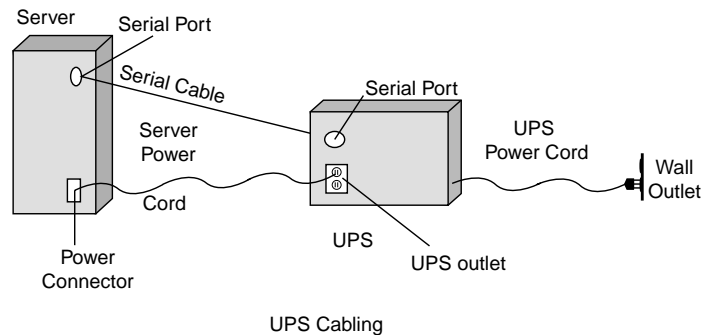
FIGURE 2.25
Cabling an uninterruptible power supply.

UPS Cabling

Miscellaneous Server Components Installation

The remaining miscellaneous server components are installed as needed.

Monitor

The monitor is connected to the video adapter via a 15-pin HD-15 connector. If the CRT monitor is to be rack mounted, it usually sits on a specially designed shelf in the rack (see Figure 2.26).

Keyboard

The keyboard plugs into the keyboard port on the server. There is no difference between plugging a keyboard into a server and plugging a keyboard into a standard desktop computer. Care must be taken not to reverse the mouse and keyboard connections, because they use the same type connector. If the keyboard is a special rack-mount keyboard, it will fit into a rack-mounted drawer in the rack. The rack-mounted keyboard may have an integrated trackball or touch pad to substitute for a mouse (see Figure 2.27).

Mouse

The mouse plugs into the mouse port (sometimes called a PS/2 mouse port) on the server. There is no difference between plugging a mouse into a server and plugging a mouse into a standard desktop computer. Care must be taken to not reverse the keyboard and mouse connections, because they use the same type PS/2 connector. A mouse with a Universal Serial Bus (USB) connector might also be utilized on a network server.
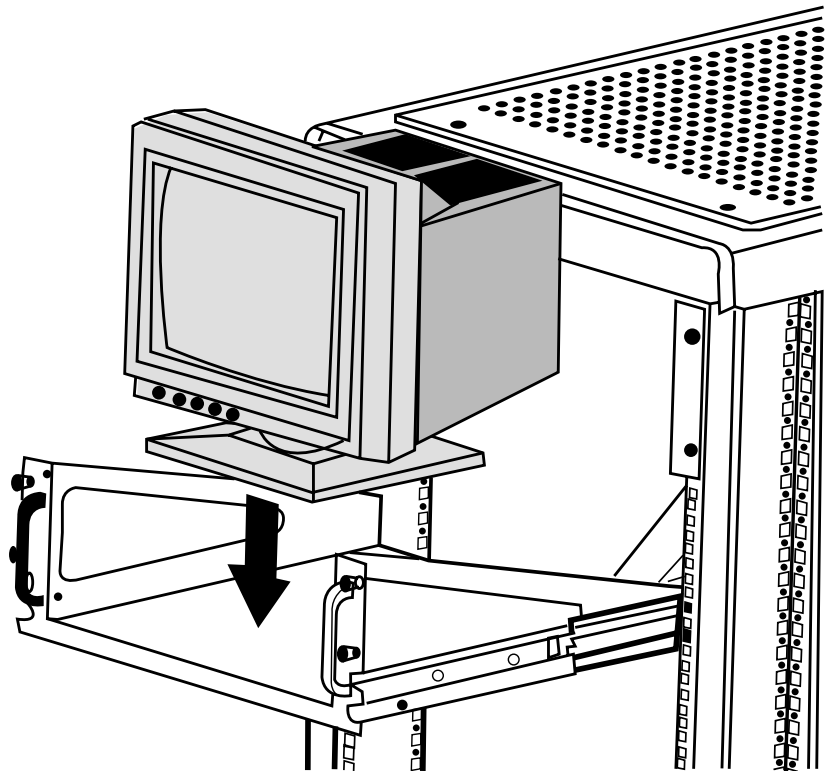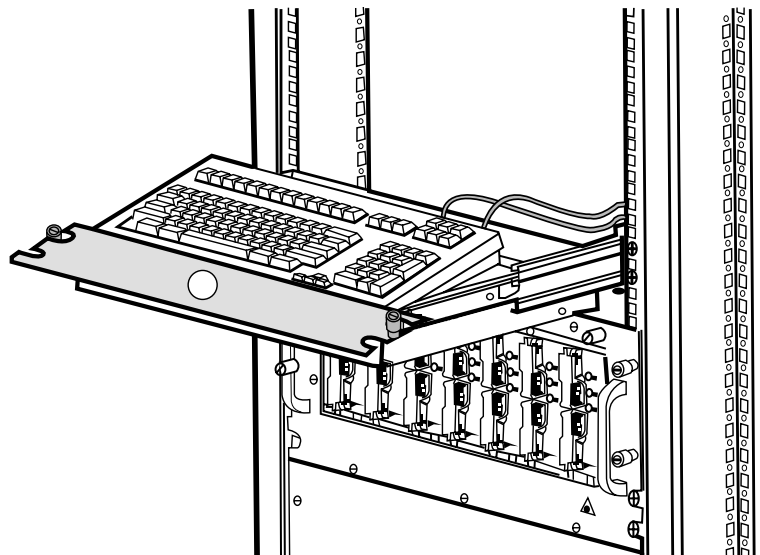
FIGURE 2.26
CRT monitor on shelf in rack.

FIGURE 2.27
Rack-mounted keyboard.

Video Adapter

The video adapter for the server may be either built in or an adapter that plugs into an available bus slot. No need for a fancy video adapter with lots of video memory. The server video display is usually used only for simple administrative tasks that do not require high resolution.

Server Management Adapter

Some vendors of network servers also sell a specialized server management adapter to aid in the management of the server hardware. This adapter usually includes a built-in modem to allow server management via a dial-in connection. Some server management adapters require that the VGA video be routed from the standard video adapter to the server management board, which then routes it to the video display. This feature allows the server management adapter to capture the boot-up sequence of the network server for playback on demand.

CD-ROM/DVD-ROM Drive

Most server hardware includes either a CD-ROM or DVD-ROM drive. This is usually required for operating system and other software installation.

Redundant Component Installation

Many times server hardware that is prone to failure will be duplicated in the server to provide redundancy. The following sections address components that are commonly set up in redundant fashion.

Power Supply

Server hardware may have multiple hot-swappable power supplies. Having two or even three power supplies allows the power supplies to balance the electrical load. If one power supply fails, the other power supply can and will handle the entire electrical load. The failed power supply can be replaced with a new power supply without taking the network server offline.

Cooling Fan

Keeping the inside of the server chassis relatively cool is of major importance. If components inside the server chassis get too hot, they will tend to fail. Server hardware has cooling fans to keep air circulating around the components. If you have only one cooling fan and it fails, the inside of the server chassis will overheat and the server will fail. Many hardware manufacturers provide the ability to add a redundant cooling fan, which is hot swappable in case of a cooling fan failure.

Redundant NIC

Having a redundant NIC in the network server will allow the network server to keep communicating over the network even if a NIC fails. This usually is accomplished by having two identical NICs in the server, only one of which is actually communicating over the network. A special software driver for the redundant NICs constantly monitors the network communications and if the software driver determines that the NIC currently being used to communicate over the network has failed, it will automatically switch to the other NIC.

Server-Rack Installation

If the network server you are installing is a rack-mount server, you must take a few special steps. You must follow the rack-installation instructions provided by the server vendor. Not only do you have to have all rack-mount components (server, UPS, monitor, keyboard/mouse, and so on), but there are also recommendations that you should follow as to the order that equipment is installed in the rack. Also, each rack-mount component has special supports that must be installed on the component and the rack to later provide access to the components installed in the rack. Because servers installed in the rack must be slid out of the rack for you to gain access to the inside of the chassis, special cable management arms are attached to the back of the components. This allows the server chassis, for example, to be slid out of the rack for access without having to disconnect any of the cables attached to the rear of the server (for instance, network cable, UPS monitor cable, SCSI cables). Figure 2.28 shows a picture of a cable management arm.

If more than one network server is installed into a single server rack, a keyboard/video/mouse (KVM) switch should also be installed to allow the use of one keyboard, one video monitor, and one mouse to control all network servers in a single rack. Figure 2.29 shows the wiring for a KVM switch.
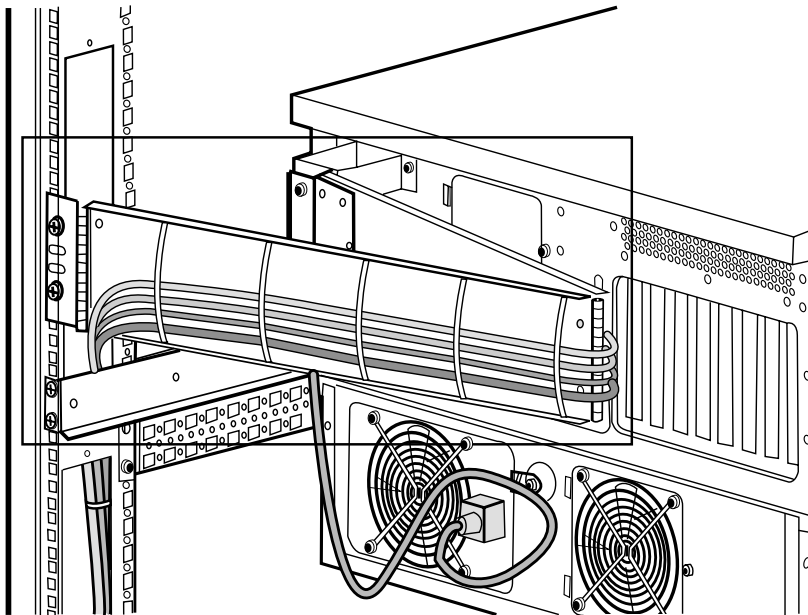

FIGURE 2.28
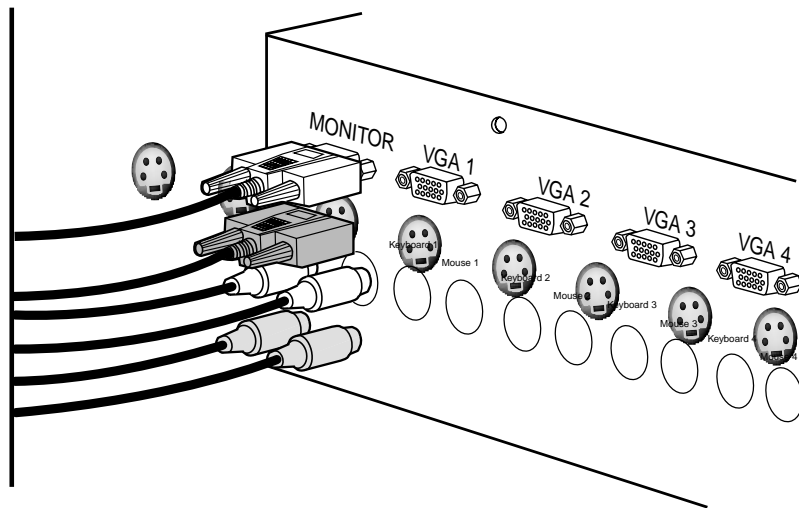Cable management arm in server rack.

FIGURE 2.29
Wiring a KVM switch.

Reinstall Chassis Covers Install all covers on the network server chassis before attempting power on. Some servers have an interlock mechanism that prevents power on if a cover is not in place.

Power-On Test

After all components have been installed into the server chassis and all external connections (keyboard, mouse, and so on) have been made, it is time to see whether the server will power on. If there are external powered devices (disk drives, tape drives), turn them on first. Then power on the server. You should see a series of messages that count the amount of RAM in the server, the number and types of processors installed, and then you should see a series of messages from the SCSI controllers as they go through and locate SCSI devices on each SCSI channel (see Figure 2.30). If you don't see the SCSI devices listed during the power- on process, read Chapter 7, "6.0—Troubleshooting and Problem Determination."

```
 524288 KB Detected
COMPAQ System BIOS - E16  (12/30/1996)
Copyright 1982, 1996 Compaq Computer Corporation. All rights reserved.

 Processor Slot  9, Processor 1 Initialized at 200 MHz
 Processor Slot  9, Processor 2 Initialized at 200 MHz
 Processor Slot 10, Processor 1 Initialized at 200 MHz
 Processor Slot 10, Processor 2 Initialized at 200 MHz

Adaptec AHA-2940  Ultra/Ultra W  BIOS v1.25
 (c) 1996 Adaptec, Inc.  All Rights Reserved.

<<<  Press <CTRL><A> for SCSISelect (TM) Utility! >>>

    SCSI ID:LUN NUMBER #:# 0:0 - COMPAQ DFHSS42       - DRIVE (80H)
    SCSI ID:LUN NUMBER #:# 1:0 - COMPAQ ST15150@      - DRIVE (80H)
    SCSI ID:LUN NUMBER #:# 2:0 - COMPAQ ST34371W      - DRIVE (80H)
    SCSI ID:LUN NUMBER #:# 3:0 - COMPAQ ST15150W      - DRIVE (80H)


 SCSI BIOS Installed Successfully!
```

FIGURE 2.30
SCSI adapter finds SCSI devices during power up.

Document, Document, Document

After the installation is complete, write down the entire hardware configuration in a log book for the network server. This information will prove to be invaluable later in the life of the server. Be sure to write down the following (at least):

◆ The amount of memory, including size and type of each memory module and which memory slot it occupies. Also record the number of available (empty) memory slots.

◆ Number of SCSI or RAID controllers.

◆ The SCSI channel, SCSI ID, size, and the speed of each SCSI disk drive.

◆ The SCSI ID of the tape backup system.

◆ The SCSI ID of the CD-ROM/DVD-ROM drive.

C HAPTER S UMMARY

KEY TERMS

- ANSI
- ATA
- ATA-2
- Bus
- Cross-over cable
- Differential
- EIDE
- Electrostatic discharge
- Ethernet

The chapter discussed verification of the installation plan and then focused on the actual installation of the hardware for a network server.

The discussion began with the verification of the installation plan. You read about the need to check the installation site for power, cooling, and network connectivity. You also learned to check the network server components that are available and compare them to the network server components as specified in the installation plan.

The discussion then turned to the process of installing the components into the network server chassis. These components include processors, memory, adapter cards (such as SCSI, RAID, FC-AL, and network). After installation of the components, you learned to run a preliminary test of the server by performing a power on.

In the next chapter, you will configure the components and install the network operating system.

CHAPTER SUMMARY

- IDE
- L2 cache
- Low-voltage differential
- Keyboard/video/mouse switch
- PCI bus
- Rack
- RAID
- RJ-45
- SCSI
- SCSI-1
- SCSI-2
- SCSI-3
- Single ended
- Standard rack unit
- Stepping
- STP
- Straight-through cable
- Token Ring
- Ultra ATA
- Ultra DMA
- Ultra SCSI
- Ultra2 SCSI
- Uninterruptible power supply
- UTP
- Wide Ultra SCSI

A P P L Y   Y O U R   K N O W L E D G E

Exercises

2.1   Becoming Familiar with IDE Disk Drives

You are probably already familiar with IDE drives and their installation in a desktop PC. Just in case you are not, this exercise runs you through some drive basics. And even if you are familiar with IDE drives, it doesn't hurt to refresh your memory.

Estimated Time: 10 minutes.

1. Get an IDE/ATA or EIDE/ATA-2 disk drive and cable.

2. Examine the disk drive. You should notice a sticker on the back of the disk drive that gives you instructions on how to set the disk drive to be a single drive, to be a Master drive, or to be a Slave drive. You might also see whether the disk drive supports CSEL. The jumper settings and their names are not standardized and therefore differ from one manufacturer to another.

3. Attach the cable to the disk drive.

2.2   Becoming Familiar with SCSI Disk Drives

The objective of this exercise is the same as that of 2.1, but as it applies to SCSI drives. You may not have the same level of familiarity with these drives because they are less often encountered in desktop machines.

Estimated Time: 10 minutes.

1. Get a SCSI disk drive and a SCSI cable.

2. Examine the disk drive. You should notice a label on the back of the disk drive that gives you instructions on how to set the SCSI ID for the disk drive.

3. Does the disk drive use a 50-pin, a 68-pin, or an 80-pin connector?

4. Attach the cable to the disk drive.

Review Questions

1. What are the different types of server chassis?

2. How big is one rack unit?

3. How do you convert watts to volt-amps?

4. What is the rule on processor steppings when multiple processors are installed in a server?

5. What is electrostatic discharge?

6. When do you use a UTP cross-over cable?

7. How many terminators are on a properly terminated SCSI bus?

8. How many ATA-2 disk drives can be connected to one ATA-2 channel?

9. How many Wide SCSI-2 disk drives can be connected to one Wide SCSI-2 channel?

10. What is a KVM switch?

11. What are the three different types of SCSI bus termination?

12. What is the maximum length of a low-voltage differential (LVD) SCSI cable?

13. What is the purpose of having redundant power supplies in a network server?

14. What is the purpose of a hardware compatibility list?

15. How is the size of an uninterruptible power supply determined?

APPLY YOUR KNOWLEDGE

Exam Questions

1. Which of the following is a connector that can be used with SCSI devices?

    A. 9-pin D connector

    B. 15-pin D connector

    C. 37-pin connector

    D. 50-pin connector

2. What is the maximum SCSI cable length for differential SCSI?

    A. 3 meters

    B. 6 meters

    C. 1.5 meters

    D. 25 meters

3. Which of the following is a typical processor L2 cache size?

    A. 32KB

    B. 64KB

    C. 512KB

    D. 4096KB

4. How many devices can be attached to a normal (narrow) SCSI channel?

    A. 2

    B. 4

    C. 7

    D. 15

5. For an Ethernet 100BASE-T network, what is the maximum cable length (UTP cable) from the hub to the server?

    A. 10 meters

    B. 100 meters

    C. 150 meters

    D. 1000 meters

6. To minimize the floor space used by multiple network servers, which type of server chassis should be utilized?

    A. Tower

    B. Wide tower

    C. Rack-mount

7. Which of the following hardware components is of little importance for a network server?

    A. Hard disk drive

    B. Processor

    C. Video adapter

    D. Memory

8. Which of the following is an advantage of SCSI over EIDE/ATA-2?

    A. SCSI is limited to two devices per channel.

    B. SCSI is limited to two channels.

    C. SCSI supports both internal and external devices.

    D. SCSI is cheaper than EIDE/ATA-2.

9. Which of the following devices is the most common device used as a backup device?

    A. Magnetic tape drive

    B. CD-R drive

    C. CD-RW drive

    D. Hard disk drive

A P P L Y   Y O U R   K N O W L E D G E

10. How many wires are in a UTP cable that is terminated with an RJ-45 connector?

    A. 2

    B. 4

    C. 6

    D. 8

11. What is the name of the tool that is used to terminate a UTP cable in an RJ-45 connector?

    A. Terminator

    B. Pliers

    C. Crimper

    D. Pincher

12. How should the jumpers on a SCSI disk drive be set in order for it to have a SCSI ID of 6?

    A. ON ON ON

    B. ON ON OFF

    C. ON OFF OFF

    D. OFF OFF OFF

13. Which of the following SCSI connectors combines the normal SCSI control lines, SCSI ID setting, and power into a single connector?

    A. 50-pin connector

    B. 68-pin connector

    C. 80-pin (SCA) connector

    D. 25-pin connector

14. What is the maximum cable length for an IDE/ATA/EIDE/ATA-2 cable?

    A. 18 inches

    B. 36 inches

    C. 72 inches

    D. 144 inches

15. If the first disk drive on an EIDE/ATA-2 channel is set to the master role, what role must a second disk drive take when attached to the same channel?

    A. Master

    B. Slave

    C. CSEL

Answers to Review Questions

1. There are three major types of chassises for servers: tower, wide tower, and rack mount. For more information, see the section "Server Chassis."

2. One standard rack unit is 1.75 inches. For more information, see the section "Server Rack."

3. A good estimate to convert watts to volt-amps is to multiply watts by 1.5. For more information, see the section "UPS Sizing Worksheet."

4. When multiple processors are installed in a network server the steppings (versions) must be within 1 number of each other (known as (N+1) stepping). For more information, see the section "Match Processor Stepping."

5. Electrostatic discharge (ESD) is the release of static electricity from a human body to an electronic component. For more information, see the section "Electrostatic Discharge."

6. UTP cross-over cables are used to connect two Ethernet hubs that do not have uplink ports. For more information, see the section "Hub to Hub."

A PPLY Y OUR K NOWLEDGE

7. A SCSI bus must be terminated on both ends, therefore two terminators are required. For more information, see the section "SCSI Disks."

8. Two ATA-2 disk drives can be connected to a single ATA-2 channel. One disk assumes the master role and the other disk assumes the slave role. For more information, see the section "EIDE/ATA-2 Disks."

9. A wide SCSI channel can support 16 devices; one must be the SCSI controller, the other 15 devices can be disk drives. For more information, see the section "SCSI-2."

10. A KVM switch (keyboard/video/mouse) permits control of several servers from a single keyboard, video monitor, and mouse. The alternative is to use a keyboard, video monitor, and mouse for *each* server. For more information, see the section "Miscellaneous Hardware."

11. The three types of SCSI bus termination are passive, active, and forced perfect. See "SCSI Disks."

12. The maximum length of a low-voltage differential (LVD) SCSI cable is 12 meters. For more information, see Table 2.1.

13. Redundant power supplies can balance the electrical load and can power the network server in the event of a single power-supply failure. For more information, see the section "Power Supply."

14. A hardware compatibility list (HCL) lists the hardware that has been verified as working with a particular network operating system. For more information, see the section "Verifying Hardware Compatibility with the Operating System."

15. An uninterruptible power supply should be large enough to keep the network server equipment running long enough to allow a graceful shutdown on the network server. For more information, see the section "Verifying the Uninterruptible Power-Supply Size."

Answers to Exam Questions

1. **D.** SCSI uses 50-pin, 68-pin, and 80-pin (SCA) connectors. For more information, see the section "SCSI Disk Types."

2. **D.** Differential SCSI has a maximum cable length of 25 meters. For more information, see Table 2.1.

3. **C.** Typical processor cache sizes are 256KB, 512KB, 1024KB, and 2048KB. For more information, see the section "Match Processor Cache Size."

4. **C.** Seven devices can be attached to a narrow SCSI channel. (There are actually 8 devices, but one of them is the SCSI controller itself.) For more information, see the section "SCSI Disks."

5. **B.** The maximum cable length between an Ethernet hub and an Ethernet NIC in a computer is 100 meters. For more information, see the section "Ethernet."

6. **C.** A rack-mount chassis is designed to use a minimum amount of floor space. In normal practice, several network servers can be installed into a single rack. For more information, see the section "Server Rack."

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7. **C.** The video adapter is the least important of the four hardware components listed for a network server. For more information, see the section "Video Adapter."

8. **C.** SCSI supports both internal devices and external devices. For more information, see the section "SCSI Disks."

9. **A.** A magnetic tape drive is the most common device used for backups. For more information, see the section "Backup System."

10. **D.** There are 8 wires (4 pairs) in a UTP cable that is terminated with an RJ-45 connector. For more information, see the section "Network Cabling."

11. **C.** The tool that is used to terminate a UTP cable in an RJ-45 connector is called a crimper. For more information, see the section "Network Cabling."

12. **B.** The SCSI jumpers set to ON ON OFF represents the SCSI ID 6. For more information, see Table 2.2.

13. **C.** The 80-pin SCA SCSI connector combines the SCSI control signals, the SCSI ID settings, and power into a single connector. For more information, see the section "SCSI-2."

14. **A.** The maximum IDE/ATA/EIDE/ATA-2 cable length is 18 inches. For more information, see the section "IDE/ATA Disks."

15. **B.** The second EIDE/ATA-2 disk drive must assume the slave role if the first disk drive is set to the master role. For more information, see the section "EIDE/ATA-2 Disks."

Suggested Readings and Resources

1. Field, Gary. *The Book of SCSI, 2nd Edition.* No Starch Press, 2000.

2. *Basics of SCSI, Fourth Edition.* ANCOT Corporation, 1998.

3. Brooks, Charles J. *A+ Certification Training Guide, Third Edition.* New Riders Publishing, 2001.

4. **SCSI FAQ**

   www.faqs.org/faqs/scsi-faq/part1/

   www.faqs.org/faqs/scsi-faq/part2/

   http://scsifaq.paralan.com/

   www.scsifaq.org/scsifaq.html

   www.scsita.org/experts/SCSI_ExpertFAQ.html

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Suggested Readings and Resources

5. **Fibre Channel FAQ**

    www.finitesystems.com/PRODUCT/san/fc/
    fcfaq.htm

6. **Disk Drives (ATA and SCSI)**

    www.seagate.com/support/kb/disc/
    index_faq.html

7. **IDE/EIDE Disk Drives FAQ**

    www.faqs.org/faqs/pc-hardware-
    faq/enhanced-IDE/part1

    www.faqs.org/faqs/pc-hardware-
    faq/enhanced-IDE/part2/

8. **Disk Drive Specifications and Jumper Settings**

    www.thetechpage.com/cgi-bin/default.cgi

    General Computer Hardware Sites

9. **The PC Guide**

    http://www.pcguide.com

10. **Tom's Hardware Guide**

    www.tomshardware.com

11. **Winn L. Rosch Hardware Bible, Electronic Edition**

    www.leroctechnologies.com/offline/
    BookInfo/Ebook/newtoc.htm

12. **Electronic Dictionaries on the World Wide Web**

    Whatis.com

    www.whatis.com

    Webopedia.com

    www.webopedia.com

13. **Free On-Line Dictionary Of Computing (FOLDOC)**

    http://foldoc.doc.ic.ac.uk/foldoc/
    index.html