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IT Essentials

PC Hardware and Software Companion Guide

Third Edition



David Anfinson • Ken Quamme

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IT Essentials: PC Hardware and Software Companion Guide

Third Edition

David Anfinson

Ken Quamme

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Dedications

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Introduction

IT Essentials: PC Hardware and Software Companion Guide, Third Edition, is a supplemental book to the Cisco Networking Academy IT Essentials: PC Hardware and Software version 4 course. The course teaches you how to build a computer and troubleshoot problems that occur in everyday use. The course is designed to prepare you to take and pass the CompTIA A+ exams (based on the 2006 objectives). By reading and completing this book, you have the opportunity to review all key concepts that the CompTIA A+ exams cover. If you use this book along with its companion *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6), you can reinforce those concepts with hands-on exercises and test that knowledge with review questions and exercises.

The IT Essentials: PC Hardware and Software course is divided into two main units. The first unit, covered in Chapters 1 through 10, goes over the foundational knowledge that aligns with the CompTIA A+ Essentials exam (220-601). The second unit, covered in Chapters 11 through 16, explores more advanced concepts in greater depth to prepare you for the specialized CompTIA A+ technician exams (220-602 for IT Technician, 220-603 for Remote Support Technician, and 220-604 for Bench Technician). You must pass both the A+ Essentials and one of the technician exams to earn the A+ certification.

The course and book also align with the objectives in the first three modules of the EUCIP IT Administrator certification (http://www.eucip.org): Module 1 PC Hardware, Module 2 Operating Systems, and Module 3 Local Area Networks and Network Services.

Who Should Read This Book

This book is intended for students in the Cisco Networking Academy IT Essentials PC Hardware and Software version 4 course. This student typically is pursuing a career in information technology (IT) or wants to have the knowledge of how a computer works, how to assemble a computer, and how to troubleshoot hardware and software issues.

Features of This Book

The features in this book facilitate an understanding of computer systems and troubleshooting system problems. The highlights of each chapter are as follows:

- **Objectives**: Each chapter starts with a list of objectives that should be mastered by the end of the chapter. The objectives provide a reference of the concepts covered in the chapter.
- **Key terms**: Each chapter includes a list of key terms in the chapter. These terms serve as a study aid and are defined in the book's glossary. The key terms reinforce the concepts introduced in the chapter and help you understand the chapter material before you

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move on to new concepts. You can find the key terms highlighted in blue throughout the chapter, where they are used in best context.

- **Explanatory text, lists, figures, and tables**: This book contains figures, procedures, and tables to accompany the thorough text explanations of the objective content and to help explain and visualize theories, concepts, commands, and setup sequences.
- **Chapter summaries**: At the end of each chapter is a summary of the concepts covered in the chapter. The summary provides a synopsis of the chapter and serves as a study aid.
- **Lab, Worksheet, Class Discussion,** and Remote Technician references: Throughout each chapter and at the end of each chapter, there are references to the Labs, Worksheets, Class Discussions, and Remote Technician exercises that can be found in the accompanying *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).
- **Virtual** Desktop Activity and Virtual Laptop Activity references: Throughout each chapter and at the end of each chapter, there are references to the Virtual Desktop activities and Virtual Laptop activities that can be found on the CD that accompanies this book.
- **"Check Your Understanding" review questions**: Review questions are presented at the end of each chapter to serve as an assessment. In addition, the questions reinforce the concepts introduced in the chapter and help test your understanding before moving on to subsequent chapters.
- **CD-ROM**: The CD that accompanies this book contains all the Virtual Desktop activities and Virtual Laptop activities referenced throughout the book. The Virtual Desktop and Virtual Laptop are standalone tools designed by Cisco to supplement classroom learning by providing a virtual "hands-on" experience where real equipment is limited. The minimum system requirements to run the Virtual Desktop and Virtual Laptop are 512 MB RAM and the Windows 2000 or XP operating system.

How This Book Is Organized

This book is divided into 16 chapters, one appendix, and a glossary of key terms:

- **Chapter 1, "Introduction to the Personal Computer":** Information technology (IT) is the design, development, implementation, support, and management of computer hardware and software applications. An IT professional is knowledgeable about computer systems and operating systems. This chapter will review IT certifications and the components of a basic personal computer system.
- **Chapter 2, "Safe Lab Procedures and Tool Use":** This chapter covers basic safety practices for the workplace, hardware and software tools, and the disposal of hazardous materials. Safety guidelines help protect individuals from accidents and injury and

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protect equipment from damage. Some of these guidelines are designed to protect the environment from contamination by discarded materials. Stay alert to situations that could result in injury or damage to equipment. Warning signs are designed to alert you to danger. Always watch for these signs and take the appropriate action according to the warning given.

- **Chapter 3, "Computer Assembly—Step by Step":** The first step in the assembly process is gathering the components and completing the computer inventory. Preparing and installing the components are detailed in a step-by-step process. In the final steps, you review the checklist, assemble the case, and boot the system for the first time. Assembling computers is a large part of a technician's job. As a technician, you will need to work in a logical, methodical manner when working with computer components. As with any learned trade, computer assembly skills will improve dramatically with practice.
- **Chapter 4, "Basics of Preventive Maintenance and Troubleshooting":** This chapter introduces preventive maintenance and the troubleshooting process. Preventive maintenance is a regular and systematic inspection, cleaning, and replacement of worn parts, materials, and systems. Preventive maintenance helps to prevent failure of parts, materials, and systems by ensuring that they are in good working order. Troubleshooting is a systematic approach to locating the cause of a fault in a computer system. A good preventive maintenance program helps minimize failures. With fewer failures, there is less troubleshooting to do, thus saving an organization time and money.
- **Chapter 5, "Fundamental Operating Systems":** The operating system (OS) controls almost all functions on a computer. In this chapter, you will learn about the components, functions, and terminology related to the Windows 2000 and Windows XP operating systems.
- **Chapter 6, "Fundamental Laptops and Portable Devices":** Laptops, personal digital assistants (PDA), and smartphones are becoming more popular as their prices decrease and technology continues to progress. As a computer technician, you need to have knowledge of portable devices of all kinds. This chapter focuses on the differences between laptops and desktops and describes the features of PDAs and smartphones.
- **Chapter 7, "Fundamental Printers and Scanners":** This chapter will provide essential information about printers and scanners. You will learn how printers operate, what to consider when purchasing a printer, and how to connect printers to an individual computer or to a network. You must understand the operation of various types of printers and scanners to be able to install and maintain them, as well as troubleshoot any problems that might arise.
- **Chapter 8, "Fundamental Networks":** This chapter will provide an overview of network principles, standards, and purposes. The different types of network topologies, protocols, and logical models, as well as the hardware needed to create a network, will also be discussed in this chapter. Configuration, troubleshooting, and preventive

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maintenance will be covered. You will also learn about network software, communication methods, and hardware relationships.

- **Chapter 9, "Fundamental Security":** Technicians need to understand computer and network security. Failure to implement proper security procedures can have an impact on users, computers, and the general public. Private information, company secrets, financial data, computer equipment, and items of national security are placed at risk if proper security procedures are not followed. This chapter will cover why security is important, security threats, security procedures, and how to troubleshoot security issues.
- **Chapter 10, "Communication Skills":** As a computer technician, you will not only fix computers but also interact with people. In fact, troubleshooting is as much about communicating with the customer as it is about knowing how to fix a computer. In this chapter, you will learn to use good communication skills as confidently as you use a screwdriver.
- **Chapter 11, "Advanced Personal Computers":** In your career as a technician, you might have to determine whether a component for a customer's computer should be upgraded or replaced. It is important that you develop advanced skills in installation procedures, troubleshooting techniques, and diagnostic methods for computers. This chapter discusses the importance of component compatibility across hardware and software. It also covers the need for adequate system resources to efficiently run the customer's hardware and software.
- **Chapter 12, "Advanced Operating Systems":** The installation, configuration, and optimization of operating systems are examined in greater detail in this chapter. There are various brands of operating systems on the market today, including Microsoft Windows, Apple Mac OS, UNIX, and Linux. A technician must consider the current computer system when selecting an operating system. Each of these operating systems offers many of the same features with a similar interface. However, some functions necessary for specific customer needs might not be available in all of them. You must be able to compare and contrast operating systems to find the best one based on your customer's needs.
- **Chapter 13, "Advanced Laptops and Portable Devices":** With the increase in demand for mobility, the popularity of laptops and portable devices will continue to grow. During the course of your career, you will be expected to know how to configure, repair, and maintain these devices. The knowledge you acquire about desktop computers will help you service laptops and portable devices. However, there are important differences between the two technologies.
- **Chapter 14, "Advanced Printers and Scanners":** This chapter explores the functionality of printers and scanners. You will learn how to maintain, install, and repair these devices in both local and network configurations. The chapter discusses safety hazards, configuration procedures, preventive maintenance, and printer and scanner sharing.

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- **Chapter 15, "Advanced Networks":** This chapter focuses on advanced networking topics, including network design, network component upgrades, and e-mail server installations. Basic networking topics such as safety, network components, and preventive maintenance are also discussed.
- **Chapter 16, "Advanced Security"**: This chapter reviews the types of attacks that threaten the security of computers and the data contained on them. A technician is responsible for the security of data and computer equipment in an organization. The chapter describes how you can work with customers to ensure that the best possible protection is in place.
- **Appendix, "Answers to Check Your Understanding Questions":** This appendix lists the answers to the Check Your Understanding review questions that are included at the end of each chapter.
- **Glossary:** The glossary provides you with definitions for all the key terms identified in each chapter.

About the A+ Certification

As a CompTIA Authorized Quality Curriculum, IT Essentials: PC Hardware and Software v4.0 will help prepare you for the new CompTIA A+ Essentials and job-skills certification exams. To become A+ certified, you will need to pass two exams to become certified in your chosen career area:

- CompTIA A+ Essentials (220-601)
- Any one of the three job-skills exams:
  - 220-602: IT Technician
  - 220-603: Remote Support Technician
  - 220-604: Depot Technician

After becoming certified, you will be qualified to work as a computer support professional and technician in a variety of work environments and industries.

The CompTIA A+ exam is explained in detail, including a list of the objectives, by visiting the following website:

http://certification.comptia.org/a/

When you are ready to take the exam, you must purchase and schedule your two A+ exams. The necessary information to accomplish this can be found at the following website:

http://certification.comptia.org/resources/registration.aspx

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CHAPTER 1

Introduction to the Personal Computer

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- What are IT industry certifications?
- What is a computer system?
- How can I identify the names, purposes, and characteristics of cases and power supplies?
- What are the names, purposes, and characteristics of internal components?
- What are the names, purposes, and characteristics of ports and cables?
- How can I identify the names, purposes, and characteristics of input devices?
- How can I identify the names, purposes, and characteristics of output devices?
- What are system resources and their purposes?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

hardware *page xx*

software *page xx*

Ohm's Law *page xx*

central processing unit (CPU) *page xx*

cache *page xx*

Reduced Instruction Set Computer (RISC) *page xx*

Complex Instruction Set Computer (CISC) *page xx*

hyperthreading *page xx*

single-core CPU *page xx*

dual-core CPU *page xx*

read-only memory (ROM) *page xx*

programmable read-only memory (PROM) *page xx*

erasable programmable read-only memory (EPROM) *page xx*

electrically erasable programmable read-only memory (EEPROM) *page xx*

random-access memory (RAM) *page xx*

dynamic RAM (DRAM) *page xx*

nonparity *page xx*

parity *page xx*

NIC *page xx*

RAID adapter *page xx*

USB port *page xx*

parallel port *page xx*

serial port *page xx*

continues

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continued

Industry Standard Architecture (ISA) *page xx*

Extended Industry Standard Architecture (EISA) *page xx*

Microchannel Architecture (MCA) *page xx*

Peripheral Component Interconnect (PCI) *page xx*

Advanced Graphics Port (AGP) *page xx*

PCI-Express *page xx*

Integrated Drive Electronics (IDE) *page xx*

Enhanced Integrated Drive Electronics (EIDE) *page xx*

Parallel ATA (PATA) *page xx*

Serial ATA (SATA) *page xx*

Small Computer System Interface (SCSI) *page xx*

FireWire *page xx*

PS/2 port *page xx*

Video Graphics Array (VGA) *page xx*

Digital Visual Interface (DVI) *page xx*

High-Definition Multimedia Interface (HDMI) *page xx*

S-Video *page xx*

Component/RGB *page xx*

CRT *page xx*

LCD *page xx*

DLP *page xx*

pixel *page xx*

dot pitch *page xx*

refresh rate *page xx*

interlaced/noninterlaced *page xx*

Horizontal Vertical Colors (HVC) *page xx*

aspect ratio *page xx*

interrupt request (IRQ) *page xx*

input/output (I/O) port address *page xx*

Direct Memory Access (DMA) *page xx*

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Information technology (IT) is the design, development, implementation, support, and management of computer hardware and software applications. An IT professional is knowledgeable about computer systems and operating systems. This chapter reviews IT certifications and the components of a basic personal computer (PC) system.

Explain IT Industry Certifications

This course focuses on desktop and laptop computers. It also discusses electronic devices, such as personal digital assistants and cell phones.

Training and experience will qualify a technician to service these computers and personal electronic devices. You will gain the specialized technical skills you need to install, maintain, and repair computers. Earning an industry-standard certification will give you confidence and increase your opportunities in IT.

This course focuses on the following two industry-standard certifications:

- The Computing Technology Industry Association (CompTIA) A+
- The European Certification of Informatics Professional (EUCIP) IT Administrator Certification (Modules 1, 2, and 3)

After completing this section, you will meet these objectives:

- Identify education and certifications.
- Describe the A+ Certification.
- Describe the EUCIP Certification.

Identify Education and Certifications

Information Technology (IT) is a term that encompasses the relationship between hardware, software, networks, and technical assistance provided to users. This book covers the information that a technician needs to be successful in IT. The IT Essentials course covers the following topics:

- PCs
- Safe lab procedures
- Troubleshooting
- Operating systems
- Laptop computers
- Printers and scanners
- Networks

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- Security
- Communication skills

This course focuses on two hardware and software skills-based industry certifications: CompTIA A+ and EUCIP. This course is only an introduction to the world of IT. A technician may continue to study and earn the following certifications:

- CCNA (Cisco Certified Networking Associate)
- CCNP (Cisco Certified Networking Professional)
- CCIE (Cisco Certified Internetworking Expert)
- CISSP (Certified Information Systems Security Professional)
- MCP (Microsoft Certified Professional)
- MCSA (Microsoft Certified Systems Administrator)
- MCSE (Microsoft Certified Systems Engineer)
- Network+ (CompTIA Network Certification)
- Linux+ (CompTIA Linux Certification)

IT certifications can be used as credits for university and college degrees in areas such as computer science and telecommunications.

Describe the A+ Certification

CompTIA developed the A+ Certification program. A CompTIA A+ certification signifies that a candidate is a qualified PC hardware and software technician. CompTIA certifications are known throughout the IT community as one of the best ways to enter the information technology field and build a solid career.

An A+ Certification candidate must pass two exams. All certification candidates must pass the A+ Essentials exam (Exam 220-601). The Essentials exam covers the basic skills needed to install, build, upgrade, repair, configure, troubleshoot, optimize, diagnose, and maintain basic PC hardware and operating systems.

The second advanced exam depends on the type of certification you want. Each advanced exam assesses specialized skills in one of the following areas:

- **IT Technician (Exam 220-602):** Assesses field-service technicians who work in both mobile and corporate technical environments.
- **Remote Support Technician (Exam 220-603):** Assesses remote-support technicians who are responsible for assisting a customer without physically touching the customer's computer. A remote technician often works in a call-center environment, where technicians resolve operating system and connectivity issues over the telephone or

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Internet. A remote-support technician is also called a help-desk technician, a call-center technician, a technical specialist, or a technical representative.

- **Depot Technician (Exam 220-604):** Assesses depot technicians, who have limited interaction with the customer and work primarily in a workshop or lab. A depot technician is also called a bench technician.



Worksheet 1.1.2: Job Opportunities

In this activity, you use the Internet, magazines, or a local newspaper to gather information on jobs in the computer service and repair field. Be prepared to discuss your research with the class. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

Describe the EUCIP Certification

The EUCIP IT Administrator program offers a recognized certification of competence in IT. The certification covers the standards prescribed by the Council of European Professional Informatics Societies (CEPIS). The EUCIP IT Administrator Certification consists of five modules, as described in the following sections, with a corresponding exam for each module. This course prepares you for Modules 1, 2, and 3.

Module 1: Computer Hardware

The Computer Hardware module requires that the candidate understand the basic makeup of a PC and the functions of the components. The candidate should be able to effectively diagnose and repair hardware problems. The candidate should be able to advise customers of appropriate hardware to buy.

Module 2: Operating Systems

The Operating Systems module requires that the candidate be familiar with the procedures for installing and updating most common operating systems and applications. The candidate should know how to use system tools to troubleshoot and repair operating systems.

Module 3: Local-Area Network and Network Services

The Local-Area Network and Network Services module requires that the candidate be familiar with the procedure of installing, using, and managing local-area networks (LAN). The candidate should be able to add and remove users and shared resources. The candidate should know how to use system tools to troubleshoot and repair networks.

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Module 4: Expert Network Use

This module is beyond the scope of the IT Essentials course, although some of the topics are covered. The Expert Network Use module requires that the candidate understand LAN communication.

Module 5: IT Security

This module is beyond the scope of the IT Essentials course, although some of the topics are covered. The IT Security module requires that the candidate be familiar with security methods and features that are available for a standalone or networked computer.

Describe a Computer System

A computer system consists of hardware and software components. ***Hardware*** is the physical equipment such as the case, storage drives, keyboards, monitors, cables, speakers, and printers. The term ***software*** includes the operating system and programs. The operating system instructs the computer how to operate. These operations may include identifying, accessing, and processing information. Programs or applications perform different functions. Programs vary widely, depending on the type of information that is accessed or generated. For example, instructions for balancing a checkbook are very different from instructions for simulating a virtual-reality world on the Internet.

The following sections discuss the hardware components found in a computer system.

Identify the Names, Purposes, and Characteristics of Cases and Power Supplies

The computer case provides protection and support for the computer's internal components. All computers need a power supply to convert alternating-current (AC) power from the wall socket into direct-current (DC) power. The size and shape of the computer case is usually determined by the motherboard and other internal components.

You can select a large computer case to accommodate additional components that may be required in the future. Other users may select a smaller case that requires minimal space. In general, the computer case should be durable and easy to service and should have enough room for expansion.

The power supply must provide enough power for the components that are currently installed and allow for additional components that may be added later. If you choose a power supply that powers only the current components, it may be necessary to replace the power supply when other components are upgraded.

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After completing this section, you will meet these objectives:

- Describe cases.
- Describe power supplies.

Describe Cases

A computer case contains the framework to support a computer's internal components while providing an enclosure for added protection. Computer cases typically are made of plastic, steel, and aluminum and are available in a variety of styles.

The size and layout of a case is called a *form factor*. There are many types of cases, but the basic form factors for computer cases include desktop and tower. Desktop cases may be slimline or full-sized, and tower cases may be mini or full-sized, as shown in Figure 1-1.

Figure 1-1 Tower Cases



Computer cases are referred to in a number of ways:

- Computer chassis
- Cabinet
- Tower
- Box
- Housing

In addition to providing protection and support, cases also provide an environment designed to keep the internal components cool. Case fans are used to move air through the computer

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case. As the air passes warm components, it absorbs heat and then exits the case. This process keeps the computer's components from overheating.

You must consider many factors when choosing a case:

- The size of the motherboard
- The number of external or internal drive locations, called bays
- Available space

When choosing a computer case, consider the following:

- **Model type:** There are two main case models. One type is for desktop PCs, and the other is for tower computers. The type of motherboard you choose determines the type of case that can be used. The size and shape must match exactly.
- **Size:** If a computer has many components, it needs more room for airflow to keep the system cool.
- **Available space:** Desktop cases allow space conservation in tight areas, because the monitor can be placed on top of the unit. The design of the desktop case may limit the number and size of the components that can be added.
- **Power supply:** You must match the power rating and connection type of the power supply to the type of motherboard you have chosen.
- **Appearance:** Some people don't care how the case looks. Others do. You have many case designs to choose from if you want an attractive case.
- **Status display:** What is going on inside the case can be very important. LED indicators that are mounted on the front of the case can tell you if the system is receiving power, when the hard drive is being used, and when the computer is on standby or sleeping.
- **Vents:** All cases have a vent on the power supply, and some have another vent on the back to help draw air into or out of the system. Some cases are designed with more vents in the event that the system needs a way to dissipate an unusual amount of heat. This situation may occur when many devices are installed close together in the case.

In addition to providing protection from the environment, cases help prevent damage from static electricity. Internal components of the computer are grounded by attachment to the case.

Note

You should select a case that matches the physical dimensions of the power supply and motherboard.

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Describe Power Supplies

The power supply, shown in Figure 1-2, converts alternating-current (AC) power coming from a wall outlet into direct-current (DC) power, which is a lower voltage. DC power is required for all the components inside the computer.

Figure 1-2 Power Supply



Connectors

Most connectors today are keyed connectors. Keyed connectors are designed to be inserted in only one direction. Each part of the connector has a colored wire with a different voltage running through it, as described in Table 1-1.

Note

Different power supply form factors provide different power output connections, depending on system requirements. AT form factors have been slowly phased out by ATX form factor power supplies because of the different case sizes and advanced features. ATXv12 was created to add power support for the motherboard by adding another four-pin power connector.

Table 1-1 Power Color Codes

Voltage	Wire Color	Use	AT Power Supply Form	ATX Power Supply Form	ATXv12 Power Supply Form
+12V	Yellow	Disk drive motors, fans, cooling devices, and system bus slots	✓	✓	✓

continues

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Table 1-1 Power Color Codes *continued*

Voltage	Wire Color	Use	AT Power Supply Form	ATX Power Supply Form	ATXv12 Power Supply Form
–12V	Blue	Some types of serial port circuits and early programmable read-only memory (PROM)	✓	✓	✓
+3.3V	Orange	Most newer CPUs, some types of system memory, and AGP video cards		✓	✓
+5V	Red	Motherboard, Baby AT and earlier CPUs, and many motherboard components	✓	✓	✓
–5V	White	ISA bus cards and early PROMS	✓	✓	✓
0V	Black	Ground: Used to complete circuits with the other voltages	✓	✓	✓

Different connectors are used to connect specific components and various locations on the motherboard:

- A Molex connector is a keyed connector used to connect to an optical drive or hard drive.
- A Berg connector is a keyed connector used to connect to a floppy drive. A Berg connector is smaller than a Molex connector.
- A 20-pin or 24-pin slotted connector is used to connect to the motherboard. The 24-pin slotted connector has two rows of 12 pins each, and the 20-pin slotted connector has two rows of 10 pins each.
- A four-pin-to-eight-pin auxiliary power connector has two rows of two to four pins and supplies power to all areas of the motherboard. The four-pin-to-eight-pin auxiliary power connector is the same shape as the main power connector, but smaller.

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- Older standard power supplies used two connectors called P8 and P9 to connect to the motherboard. P8 and P9 were unkeyed connectors. They could be installed backwards, potentially damaging the motherboard or power supply. The installation required that the connectors were lined up with the black wires together in the middle.

Note

If you have a difficult time inserting a connector, try a different way, or check to make sure that no bent pins or foreign objects are in the way. Remember, if it seems difficult to plug in any cable or other part, something is wrong. Cables, connectors, and components are designed to fit together snugly. Never force any connector or component. Connectors that are plugged in incorrectly will damage the plug and the connector. Take your time, and make sure that you are handling the hardware correctly.

Electricity and Ohm's Law

The four basic units of electricity are

- Voltage (V)
- Current (I)
- Power (P)
- Resistance (R)

Voltage, current, power, and resistance are electronics terms that a computer technician must know:

- **Voltage** is a measure of the force required to push electrons through a circuit. Voltage is measured in volts (V). A computer power supply usually produces several different voltages.
- **Current** is a measure of the number of electrons going through a circuit. Current is measured in amperes, or amps (A). Computer power supplies deliver different amperages for each output voltage.
- **Power** is a measure of the pressure required to push electrons through a circuit, called voltage, multiplied by the number of electrons going through that circuit, called current. The measurement is called watts (W). Computer power supplies are rated in watts.
- **Resistance** is the opposition to the flow of current in a circuit. Resistance is measured in ohms. Lower resistance allows more current, and therefore more power, to flow through a circuit. A good fuse has low resistance or a measurement of almost 0 ohms.

Here's a basic equation that expresses how voltage, current, and resistance relate to each other:

$$V = IR$$

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This equation, known as ***Ohm's Law***, states that voltage is equal to the current multiplied by the resistance.

In an electrical system, power (P) is equal to the voltage multiplied by the current, as expressed by the following equation:

P = VI

In an electrical circuit, increasing the current or voltage results in higher power.

As an example of how this works, imagine a simple circuit that has a 9-V light bulb hooked up to a 9-V battery. The power output of the light bulb is 100 W. Using the equation to calculate power, you can calculate how much current in amps would be required to get 100 W out of this 9-V bulb.

To solve this equation, you use the following information that you know:

P = 100 W

V = 9 V

So:

I = 100 W / 9 V = 11.11 A

What happens if a 12-V battery and a 12-V light bulb are used to get 100 W of power?

100 W / 12 V = 8.33 amps

This system produces the same power, but with less current.

Computers normally use power supplies ranging from 200 W to 500 W. However, some computers may need 500-W to 800-W power supplies. When building a computer, select a power supply with sufficient wattage to power all the components. Obtain the wattage information for the components from the manufacturer's documentation. When deciding on a power supply, be sure to choose a power supply that has more than enough power for the current components.

Caution

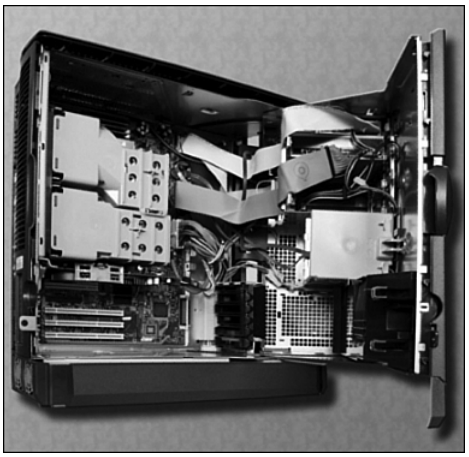
Do not open a power supply. Electronic capacitors located inside a power supply can hold a charge for extended periods of time.

Identify the Names, Purposes, and Characteristics of Internal Components

This section discusses the names, purposes, and characteristics of a computer's internal components, as shown in Figure 1-3.

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Figure 1-3 Computer Components



After completing this section, you will meet these objectives:

- Identify the names, purposes, and characteristics of motherboards.
- Identify the names, purposes, and characteristics of CPUs.
- Identify the names, purposes, and characteristics of cooling systems.
- Identify the names, purposes, and characteristics of ROM and RAM.
- Identify the names, purposes, and characteristics of adapter cards.
- Identify the names, purposes, and characteristics of storage drives.
- Identify the names, purposes, and characteristics of internal cables.

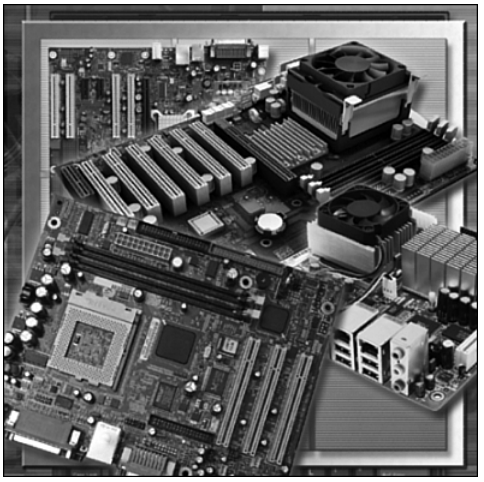
Identify the Names, Purposes, and Characteristics of Motherboards

The motherboard is the main printed circuit board. It contains the buses, or electrical pathways, found in a computer. These buses allow data to travel between the various components that comprise a computer. A motherboard is also known as the system board, backplane, or main board. Figure 1-4 shows a variety of motherboards.

The motherboard accommodates the central processing unit (CPU), RAM, expansion slots, heat sink/fan assembly, BIOS chip, chip set, and the embedded wires that interconnect the motherboard components. Sockets, internal and external connectors, and various ports are also placed on the motherboard.

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Figure 1-4 Motherboards



The form factor of motherboards pertains to the board's size and shape. It also describes the physical layout of the different components and devices on the motherboard. Motherboards have various form factors:

- Advanced Technology (AT)
- Advanced Technology Extended (ATX)
- Smaller footprint than Advanced Technology Extended (Mini-ATX)
- Smaller footprint than Advanced Technology Extended (Micro-ATX)
- Low-Profile Extended (LPX)
- New Low-Profile Extended (NLX)
- Balanced technology Extended (BTX)

An important set of components on the motherboard is the chip set. The chip set is composed of various integrated circuits attached to the motherboard that control how system hardware interacts with the CPU and motherboard. The CPU is installed into a slot or socket on the motherboard. The socket on the motherboard determines the type of CPU that can be installed.

The chip set of a motherboard allows the CPU to communicate and interact with the computer's other components and to exchange data with system memory (RAM), hard-disk drives, video cards, and other output devices. The chip set establishes how much memory can be added to a motherboard. The chip set also determines the type of connectors on the motherboard.

Most chip sets are divided into two distinct components, northbridge and southbridge. What each component does varies from manufacturer to manufacturer, but in general the north-

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bridge controls access to the RAM, video card, and the speeds at which the CPU can communicate with them. The video card is sometimes integrated into the northbridge. The southbridge, in most cases, allows the CPU to communicate with the hard drives, sound card, USB ports, and other input/output (I/O) ports.

Identify the Names, Purposes, and Characteristics of CPUs

The ***central processing unit (CPU)*** is considered the computer's brain. It is sometimes called the processor. Most calculations take place in the CPU. In terms of computing power, the CPU is the most important element of a computer system. CPUs come in different form factors, each style requiring a particular slot or socket on the motherboard. Common CPU manufacturers include Intel and AMD.

The CPU socket or slot is the connector that is the interface between the motherboard and the processor. Most CPU sockets and processors in use today are built around the pin grid array (PGA) architecture, in which the pins on the underside of the processor are inserted into the socket, usually with zero insertion force (ZIF). ZIF refers to the amount of force needed to install a CPU into the motherboard socket or slot. Slot-based processors are cartridge-shaped and fit into a slot that looks similar to an expansion slot. Tables 1-2 through 1-8 list common CPU socket specifications.

Table 1-2 CPU Socket Specifications: Intel/AMD 486 Class

Socket	Pins	Layout	Voltage	Supported Processors
Socket 1	169	17×17 PGA	5 V	486 SX/SX2, DX/DX2, DX4 OD
Socket 2	238	19×19 PGA	5 V	486 SX/SX2, DX/DX2, DX4 OD, 486 Pentium OD
Socket 3	237	19×19 PGA	5 /3.3 V	486 SX/SX2, DX/DX2, DX4, 486 Pentium OD, AMD 5x86
Socket 6	235	19×19 PGA	3.3 V	486 DX4, 486 Pentium OD

Table 1-3 CPU Socket Specifications: Intel/AMD 586 (Pentium) Class

Socket	Pins	Layout	Voltage	Supported Processors
Socket 4	273	21×21 PGA	5 V	Pentium 60/66, OD
Socket 5	320	37×37 SPGA	3.3 V/3.5 V	Pentium 75-133, OD
Socket 7	321	37×37 SPGA	VRM	Pentium 75-233+, MMX, OD, AMD K5/K6, Cyrix M1/ll

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Table 1-4 CPU Socket Specifications: Intel 686 (Pentium II/III) Class

Socket	Pins	Layout	Voltage	Supported Processors
Socket 8	387	Dual-pattern SPGA	Auto VRM	Pentium Pro, OD
Slot 1 (SC242)	242	Slot	Auto VRM	Pentium II/III, Celeron SECC
Socket 370	370	37×37 SPGA	Auto VRM	Celeron/Pentium III PPGA/FC-PGA

Table 1-5 CPU Socket Specifications: Pentium 4 Class

Socket	Pins	Layout	Voltage	Supported Processors
Socket 423	423	39×39 SPGA	Auto VRM	Pentium 4 FC-PGA
Socket 478	478	26×26m PGA	Auto VRM	Pentium 4/ Celeron FC-PGA2
Socket T (LGA775)	775	30×33 LGA	Auto VRM	Pentium 4/ Celeron LGA775

Table 1-6 CPU Socket Specifications: AMD K7 Class

Socket	Pins	Layout	Voltage	Supported Processors
Slot A	242	Slot	Auto VRM	AMD Athlon SECC
Socket A (462)	462	37×37 SPGA	Auto VRM	AMD Athlon/Athlon XP/Duron PGA/ FC-PGA

Table 1-7 CPU Socket Specifications: AMD K8 Class[2]

Socket	Pins	Layout	Voltage	Supported Processors
Socket 754	754	29×29 mPGA	Auto VRM	AMD Athlon 64
Socket 939	939	31×31 mPGA	Auto VRM	AMD Athlon 64 v.2
Socket 940	940	31×31 mPGA	Auto VRM	AMD Athlon 64FX, Opteron

Table 1-8 CPU Socket Specifications: Intel/AMD Server and Workstation Class

Socket	Pins	Layout	Voltage	Supported Processors
Slot 2	330	Slot	Auto VRM	Pentium II/III Xeon
Socket 603	603	31×25 mPGA	Auto VRM	Xeon (P4)

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Socket	Pins	Layout	Voltage	Supported Processors
PAC 418 Socket	611	25×28 mPGA	Auto VRM	Itanium 2
PAC 611 Socket 940	940	31×31 mPGA	Auto VRM	AMD Athlon 64FX, Opteron

The CPU executes a program, which is a sequence of stored instructions. Each model of processor has an instruction set, which it executes. The CPU executes the program by processing each piece of data as directed by the program and the instruction set. While the CPU is executing one step of the program, the remaining instructions and the data are stored nearby in a special memory called ***cache***. Two major CPU architectures are related to instruction sets:

- ***Reduced Instruction Set Computer (RISC)***: Architectures use a relatively small set of instructions, and RISC chips are designed to execute these instructions very rapidly.
- ***Complex Instruction Set Computer (CISC)***: Architectures use a broad set of instructions, resulting in fewer steps per operation.

Some CPUs incorporate hyperthreading to enhance the CPU's performance. With ***hyperthreading***, the CPU has multiple pieces of code being executed simultaneously on each pipeline. To an operating system, a single CPU with hyperthreading appears to be two CPUs.

A CPU's power is measured by its speed and the amount of data it can process. A CPU's speed is rated in cycles per second. The speed of current CPUs is measured in millions of cycles per second, called megahertz (MHz), or billions of cycles per second, called gigahertz (GHz). The amount of data that a CPU can process at the one time depends on the size of the processor data bus. This is also called the CPU bus or the front-side bus (FSB). The wider the processor data bus, the more powerful the processor. Current processors have a 32-bit or 64-bit processor data bus.

Overclocking is a technique used to make a processor work at a faster speed than its original specification. Overclocking is an unreliable way to improve computer performance and can damage the CPU.

MMX is a set of multimedia instructions built into Intel processors. MMX-enabled microprocessors can handle many common multimedia operations that normally are handled by a separate sound or video card. However, only software specially written to call MMX instructions can take advantage of the MMX instruction set.

The latest processor technology has caused CPU manufacturers to find ways to incorporate more than one CPU core into a single chip. Many CPUs can process multiple instructions concurrently:

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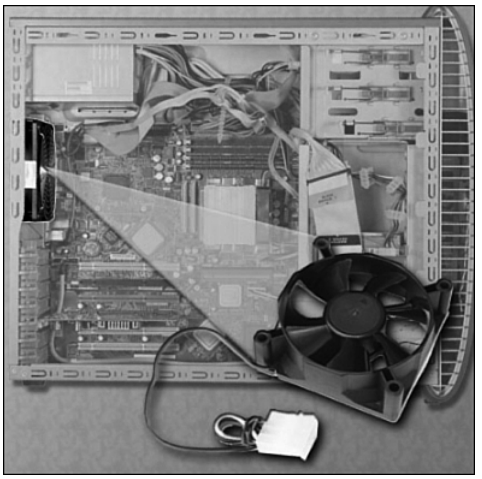
- ***Single-core CPU***: One core inside a single CPU chip that handles all the processing capability. A motherboard manufacturer may provide sockets for more than a single processor, providing the ability to build a powerful multiprocessor computer.
- ***Dual-core CPU***: Two cores inside a single CPU chip, in which both cores can process information at the same time.

Identify the Names, Purposes, and Characteristics of Cooling Systems

Electronic components generate heat. Heat is caused by the flow of current within the components. Computer components perform better when kept cool. If the heat is not removed, the computer may run slower. If too much heat builds up, computer components can be damaged.

Increasing the air flow in the computer case allows more heat to be removed. A case fan, shown in Figure 1-5, is installed in the computer case to make the cooling process more efficient.

Figure 1-5 Case Fan



In addition to case fans, a heat sink draws heat away from the core of the CPU. A fan on top of the heat sink moves the heat away from the CPU, as shown in Figure 1-6.

Other components are also susceptible to heat damage and sometimes are equipped with fans. Video adapter cards produce a great deal of heat. Fans are dedicated to cooling the graphics-processing unit (GPU), as shown in Figure 1-7.

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Figure 1-6 CPU Fans

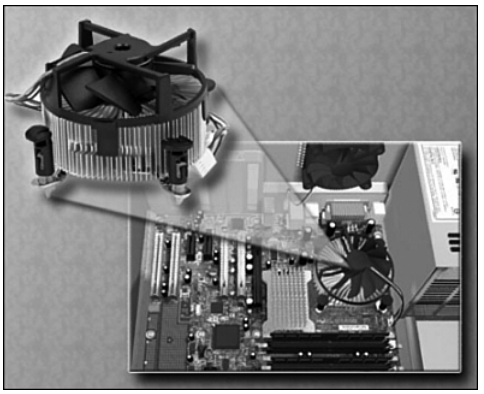
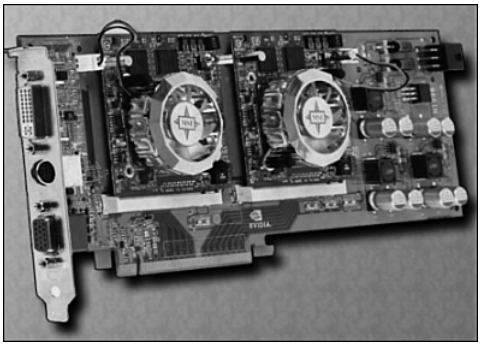


Figure 1-7 Graphics Card Cooling System



Computers with extremely fast CPUs and GPUs may use a water-cooling system. A metal plate is placed over the processor, and water is pumped over the top to collect the heat that the CPU creates. The water is pumped to a radiator to be cooled by the air and then is recirculated.

Identify the Names, Purposes, and Characteristics of ROM and RAM

ROM and RAM provide memory for a vast amount of computer equipment. They come in different memory sizes and module sizes and have different features. The following sections cover ROM and RAM in greater detail.

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ROM

Read-only memory (ROM) chips are located on the motherboard. ROM chips contain instructions that the CPU can access directly. ROM stores basic instructions for booting the computer and loading the operating system. ROM chips retain their contents even when the computer is powered down. The contents cannot be erased, changed, or rewritten by normal means. ROM types include the following:

- ***Programmable read-only memory (PROM)*:** Information is written to a PROM chip after it is manufactured. A PROM chip cannot be erased or rewritten.
- ***Erasable programmable read-only memory (EPROM)*:** Information is written to an EPROM chip after it is manufactured. An EPROM chip can be erased with exposure to UV light. Special equipment is required.
- ***Electrically erasable programmable read-only memory (EEPROM)*:** Information is written to an EEPROM chip after it is manufactured. EEPROM chips are also called flash ROMs. An EEPROM chip can be erased and rewritten without removing the chip from the computer.

Note

ROM is sometimes called firmware. This is misleading, because firmware is actually the software that is stored in a ROM chip.

RAM

Random-access memory (RAM) is the temporary storage for data and programs that are being accessed by the CPU. RAM is volatile memory, which means that the contents are erased when the computer is powered off. The more RAM in a computer, the more capacity the computer has to hold and process large programs and files, as well as enhance system performance. The different types of RAM are as follows:

- ***Dynamic RAM (DRAM)*** is a memory chip that is used as main memory. DRAM must be constantly refreshed with pulses of electricity to maintain the data stored in the chip.
- Static RAM (SRAM) is a memory chip that is used as cache memory. SRAM is much faster than DRAM and does not have to be refreshed as often.
- Fast Page Mode (FPM) DRAM is memory that supports paging. Paging enables faster access to the data than regular DRAM. Most 486 and Pentium systems from 1995 and earlier use FPM memory.
- Extended Data Out (EDO) RAM is memory that overlaps consecutive data accesses. This speeds up the access time to retrieve data from memory, because the CPU does not have to wait for one data access cycle to end before another data access cycle begins.

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- Synchronous DRAM (SDRAM) is DRAM that operates in synchronization with the memory bus. The memory bus is the data path between the CPU and the main memory.
- Double Data Rate (DDR) SDRAM is memory that transfers data twice as fast as SDRAM. DDR SDRAM increases performance by transferring data twice per cycle.
- Double Data Rate 2 (DDR2) SDRAM is faster than DDR-SDRAM memory. DDR2 SDRAM improves performance over DDR SDRAM by decreasing noise and crosstalk between the signal wires.
- RAMBus DRAM (RDRAM) is a memory chip that was developed to communicate at very high rates of speed. RDRAM chips are not commonly used.

Memory Modules

Early computers had RAM installed on the motherboard as individual chips. These individual memory chips, called dual inline package (DIP) chips, were difficult to install and often became loose on the motherboard. To solve this problem, designers soldered the memory chips on a special circuit board called a memory module. The different types of memory modules are as follows:

- **Dual Inline Package (DIP)** is an individual memory chip. A DIP had dual rows of pins used to attach it to the motherboard.
- **Single Inline Memory Module (SIMM)** is a small circuit board that holds several memory chips. SIMMs have 30-pin and 72-pin configurations.
- **Dual Inline Memory Module (DIMM)** is a circuit board that holds SDRAM, DDR SDRAM, and DDR2 SDRAM chips. There are 168-pin SDRAM DIMMs, 184-pin DDR DIMMs, and 240-pin DDR2 DIMMs.
- **RAM Bus Inline Memory Module (RIMM)** is a circuit board that holds RDRAM chips. A typical RIMM has a 184-pin configuration.

Note

Memory modules can be single-sided or double-sided. Single-sided memory modules contain RAM on only one side of the module. Double-sided memory modules contain RAM on both sides of the module.

Cache Memory

SRAM is used as cache memory to store the most frequently used data. SRAM gives the processor faster access to the data than retrieving it from the slower DRAM, or main memory. The three types of cache memory are as follows:

- **L1** is internal cache integrated into the CPU.

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- **L2** is external cache originally mounted on the motherboard near the CPU. L2 cache is now integrated into the CPU.
- **L3** is used on some high-end workstations and server CPUs.

Error Checking

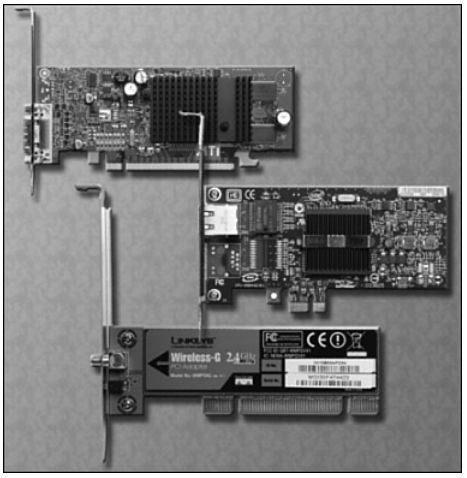
Memory errors occur when the data is stored incorrectly in the RAM chips. The computer uses different methods to detect and correct data errors in memory. Three different methods of memory error checking are as follows:

- ***Nonparity*** does not check for errors in memory.
- ***Parity*** contains 8 bits for data and 1 bit for error checking. The error-checking bit is called a parity bit.
- **Error Correction Code (ECC)** can detect multiple bit errors in memory and correct single bit errors in memory.

Identify the Names, Purposes, and Characteristics of Adapter Cards

Adapter cards increase a computer's functionality by adding controllers for specific devices or by replacing malfunctioning ports. Figure 1-8 shows several types of adapter cards.

Figure 1-8 Adapter Cards



Adapter cards are used to expand and customize the computer's capability:

- ***NIC*** connects a computer to a network using a network cable.
- **Wireless NIC** connects a computer to a network using radio frequencies.

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- **Sound adapter** provides audio capability.
- **Video adapter** provides graphic capability.
- **Modem adapter** connects a computer to the Internet using a phone line.
- **SCSI adapter** connects SCSI devices, such as hard drives or tape drives, to a computer.
- ***RAID adapter*** connects multiple hard drives to a computer to provide redundancy and to improve performance.
- ***USB port*** connects a computer to peripheral devices.
- ***Parallel port*** connects a computer to peripheral devices.
- ***Serial port*** connects a computer to peripheral devices.

Computers have expansion slots on the motherboard to install adapter cards. The type of adapter card connector must match the expansion slot. A riser card is used in computer systems with the LPX form factor to allow adapter cards to be installed horizontally. The riser card is mainly used in slimline desktop computers. The different types of expansion slots are as follows:

- ***Industry Standard Architecture (ISA)*** is an 8-bit or 16-bit expansion slot. This is older technology and is seldom used.
- ***Extended Industry Standard Architecture (EISA)*** is a 32-bit expansion slot. This is older technology and is seldom used.
- ***Microchannel Architecture (MCA)*** is an IBM-proprietary 32-bit expansion slot. This is older technology and is seldom used.
- ***Peripheral Component Interconnect (PCI)*** is a 32-bit or 64-bit expansion slot. PCI is the standard slot currently used in most computers.
- ***Advanced Graphics Port (AGP)*** is a 32-bit expansion slot. AGP is designed for video adapters.
- ***PCI-Express*** is a serial bus expansion slot. PCI-Express is backward-compatible with PCI slots. PCI-Express has x1, x4, x8, x16 slots.

Identify the Names, Purposes, and Characteristics of Storage Drives

A storage drive reads or writes information to magnetic or optical storage media. It can be used to store data permanently or to retrieve information from a media disk. Storage drives can be installed inside the computer case, such as a hard drive. For portability, some storage drives can connect to the computer using a USB port, a FireWire port, or a SCSI port.

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These portable storage drives are sometimes called removable drives and can be used on multiple computers. Figure 1-9 shows some common types of storage drives:

- Floppy drive
- Hard drive
- Optical drive
- Flash drive
- Network drive (not shown in Figure 1-9)

Figure 1-9 Storage Drives



The following sections describe these storage drives in greater detail.

Floppy Drives

A floppy drive, or floppy disk drive, is a storage device that uses removable 3.5-inch floppy disks. These magnetic floppy disks can store 720 KB or 1.44 MB of data. In a computer, the floppy drive is usually configured as the A: drive. The floppy drive can be used to boot the computer if it contains a bootable floppy disk. A 5.25-inch floppy drive is older technology and is seldom used.

The floppy drive is slowly being replaced by cheaper, faster, and larger-capacity storage such as writable CDs, DVDs, and flash drive media.

Hard Drives

A hard drive, or hard-disk drive, is a magnetic storage device that is installed inside the computer. The hard drive is used as permanent storage for data. In a computer, the hard drive is usually configured as the C: drive and contains the operating system and applications. The hard drive is usually configured as the first drive in the boot sequence. The

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storage capacity of a hard drive is measured in billions of bytes, or gigabytes (GB). The speed of a hard drive is measured in revolutions per minute (rpm). Multiple hard drives can be added to increase storage capacity.

Optical Drives

An optical drive is a storage device that uses lasers to read data on the optical media. Two types of optical drives exist:

- Compact disc (CD)
- Digital versatile disc (DVD)

CD and DVD media can be prerecorded (read-only), recordable (write once), or rerecordable (read and write multiple times). CDs have a data storage capacity of approximately 700 MB. DVDs have a data storage capacity of approximately 8.5 GB on one side of the disc.

Several types of optical media exist:

- **CD-ROM** is CD read-only memory media that is prerecorded.
- **CD-R** is CD recordable media that can be recorded once.
- **CD-RW** is CD rewritable media that can be recorded, erased, and rerecorded.
- **DVD-ROM** is DVD read-only memory media that is prerecorded.
- **DVD-RAM** is DVD random-access memory media that can be recorded, erased, and rerecorded.
- **DVD+/-R** is DVD recordable media that can be recorded once.
- **DVD+/-RW** is DVD rewritable media that can be recorded, erased, and rerecorded.

Flash Drives

A flash drive, also known as a thumb drive, is a removable storage device that connects to a USB port. A flash drive uses a special type of memory that requires no power to maintain the data. These drives can be accessed by the operating system in the same way other types of drives are accessed.

The storage capacity of a flash drive varies from a couple of megabytes to 16 gigabytes.

Network Drives

A network drive is a connection to a remote computer's storage for access to files, directories, and applications. Network connections are covered in more detail in later chapters.

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Types of Drive Interfaces

Hard drives and optical drives are manufactured with different interfaces that are used to connect the drive to the computer. When you install a storage drive in a computer, the connection interface on the drive must be the same as the controller on the motherboard. Some common drive interfaces are as follows:

- ***Integrated Drive Electronics (IDE)***, also called Advanced Technology Attachment (ATA), is an early drive controller interface that connects computers and hard-disk drives. An IDE interface uses a 40-pin connector.
- ***Enhanced Integrated Drive Electronics (EIDE)***, also called ATA-2, is an updated version of the IDE drive controller interface. EIDE supports hard drives larger than 512 MB, enables Direct Memory Access (DMA) for speed, and uses the AT Attachment Packet Interface (ATAPI) to accommodate optical drives and tape drives on the EIDE bus. An EIDE interface uses a 40-pin connector.
- ***Parallel ATA (PATA)*** refers to the parallel version of the ATA drive controller interface.
- ***Serial ATA (SATA)*** refers to the serial version of the ATA drive controller interface. A SATA interface uses a seven-pin connector.
- ***Small Computer System Interface (SCSI)*** is a drive controller interface that can connect up to 15 drives. SCSI can connect both internal and external drives. A SCSI interface uses a 50-pin, 68-pin, or 80-pin connector.

Identify the Names, Purposes, and Characteristics of Internal Cables

Drives require both a power cable and a data cable. A power supply has a SATA power connector for SATA drives, a Molex power connector for PATA drives, and a Berg four-pin connector for floppy drives. The buttons and the LED lights on the front of the case connect to the motherboard with the front panel cables. Figure 1-10 shows some examples of internal PC cables.

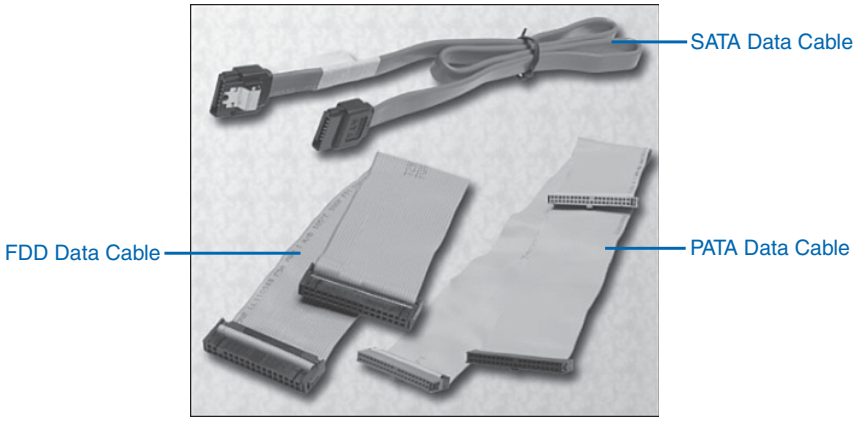
Data cables connect drives to the drive controller, which is located on an adapter card or the motherboard. Some common types of data cables are as follows:

- Floppy disk drive (FDD) data cable has up to two 34-pin drive connectors and one 34-pin connector for the drive controller.
- PATA (IDE) data cable has 40 conductors, up to two 40-pin connectors for drives, and one 40-pin connector for the drive controller.
- PATA (EIDE) data cable has 80 conductors, up to two 40-pin connectors for drives, and one 40-pin connector for the drive controller.
- SATA data cable has seven conductors, one keyed connector for the drive, and one keyed connector the drive controller.

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- SCSI data cable: Three types of SCSI data cables exist:
  - A narrow SCSI data cable has 50 conductors, up to seven 50-pin connectors for drives, and one 50-pin connector for the drive controller, also called the host adapter.
  - A wide SCSI data cable has 68 conductors, up to 15 68-pin connectors for drives, and one 68-pin connector for the host adapter.
  - An Alt-4 SCSI data cable has 80 conductors, up to 15 80-pin connectors for drives, and one 80-pin connector for the host adapter.

Figure 1-10 Internal PC Cables



Note

A colored stripe on a cable identifies Pin 1 on the cable. When installing a data cable, always ensure that Pin 1 on the cable aligns with Pin 1 on the drive or drive controller. Some cables may be keyed; therefore, they can be connected only one way to the drive and drive controller.

Worksheet 1.4.7: Research Computer Components

In this worksheet, you use the Internet, a newspaper, or a local store to gather information about the components you need to complete your customer's computer from the scenario provided. Be prepared to discuss your selections. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

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Identify the Names, Purposes, and Characteristics of Ports and Cables

I/O ports on a computer connect peripheral devices, such as printers, scanners, and portable drives. The following ports and cables are commonly used:

- Serial
- USB
- FireWire
- Parallel
- SCSI
- Network
- PS/2
- Audio
- Video

The following sections explain port and cable topics in greater detail.

Serial Ports and Cables

A serial port can be either a DB-9, as shown in Figure 1-11, or a DB-25 male connector. Serial ports transmit 1 bit of data at a time. To connect a serial device, such as a modem or printer, a serial cable must be used. A serial cable has a maximum length of 50 feet (15.2 m).

Figure 1-11 Serial Ports and Cables



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USB Ports and Cables

The Universal Serial Bus (USB) is a standard interface that connects peripheral devices to a computer. It was originally designed to replace serial and parallel connections. USB devices are hot-swappable, which means that users can connect and disconnect the devices while the computer is powered on. USB connections can be found on computers, cameras, printers, scanners, storage devices, and many other electronic devices. A USB hub is used to connect multiple USB devices. A single USB port in a computer can support up to 127 separate devices with the use of multiple USB hubs. Some devices can also be powered through the USB port, eliminating the need for an external power source. Figure 1-12 shows USB cables with connectors.

Figure 1-12 USB Connectors



USB 1.1 allowed transmission rates of up to 12 Mbps in full-speed mode and 1.5 Mbps in low-speed mode. USB 2.0 allows transmission speeds up to 480 Mbps. USB devices can only transfer data up to the maximum speed allowed by the specific port.

FireWire Ports and Cables

FireWire is a high-speed, hot-swappable interface that connects peripheral devices to a computer. A single FireWire port in a computer can support up to 63 devices. Some devices can also be powered through the FireWire port, eliminating the need for an external power source. FireWire uses the IEEE 1394 standard and is also known as i.Link.

The IEEE 1394a standard supports data rates up to 400 Mbps and cable lengths up to 15 feet (4.5 m). This standard uses a six-pin connector or a four-pin connector. The IEEE 1394b standard supports data rates in excess of 800 Mbps and uses a nine-pin connector. Figure 1-13 shows FireWire cables with connectors.

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Figure 1-13 FireWire Connectors



Parallel Ports and Cables

A parallel port on a computer is a standard Type A DB-25 female connector. The parallel connector on a printer is a standard Type B 36-pin Centronics connector. Some newer printers may use a Type C high-density 36-pin connector. Parallel ports can transmit 8 bits of data at a time and use the IEEE 1284 standard. To connect a parallel device, such as a printer, a parallel cable must be used. A parallel cable, as shown in Figure 1-14, has a maximum length of 15 feet (4.5 m).

Figure 1-14 Parallel Cable



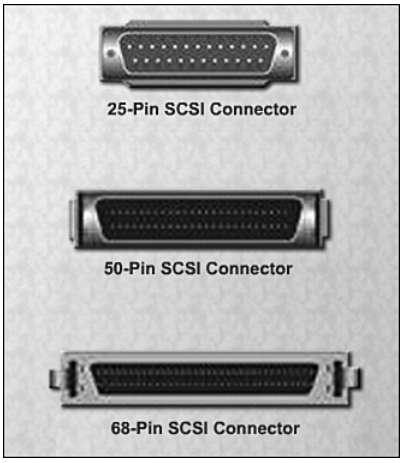
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SCSI Ports and Cables

A SCSI port can transmit data at rates in excess of 320 Mbps and can support up to 15 devices. If a single SCSI device is connected to a SCSI port, the cable can be up to 80 feet (24.4 m) in length. If multiple SCSI devices are connected to a SCSI port, the cable can be up to 40 (12.2 m) feet in length. A SCSI port on a computer can be one of three different types, as shown in Figure 1-15:

- DB-25 female connector
- High-density 50-pin female connector
- High-density 68-pin female connector

Figure 1-15 SCSI Connectors



Note

SCSI devices must be terminated at the endpoints of the SCSI chain. Check the device manual for termination procedures.

Caution

Some SCSI connectors resemble parallel connectors. Be careful not to connect the cable to the wrong port. The voltage used in the SCSI format may damage the parallel interface. SCSI connectors should be clearly labeled.

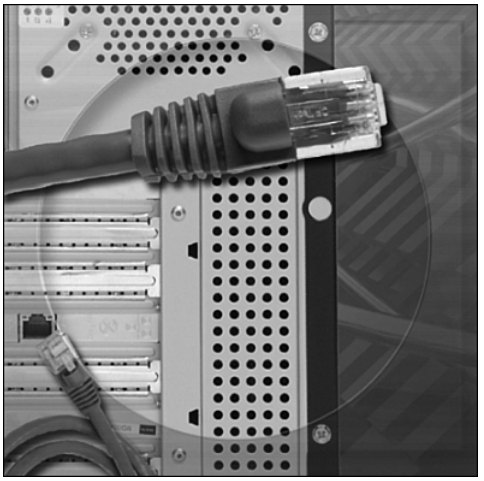
Network Ports and Cables

A network port, also called an RJ-45 port, connects a computer to a network. The connection speed depends on the type of network port. Standard Ethernet can transmit up to 10 Mbps, Fast Ethernet can transmit up to 100 Mbps, and Gigabit Ethernet can transmit up to

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1000 Mbps. The maximum length of network cable is 328 feet (100 m). Figure 1-16 shows a network connector.

Figure 1-16 Network Connector



PS/2 Ports

A ***PS/2 port*** connects a keyboard or mouse to a computer. The PS/2 port is a six-pin mini-DIN female connector. The connectors for the keyboard and mouse are often colored differently, as shown in Figure 1-17. If the ports are not color-coded, look for a small figure of a mouse or keyboard next to each port.

Figure 1-17 PS/2 Ports



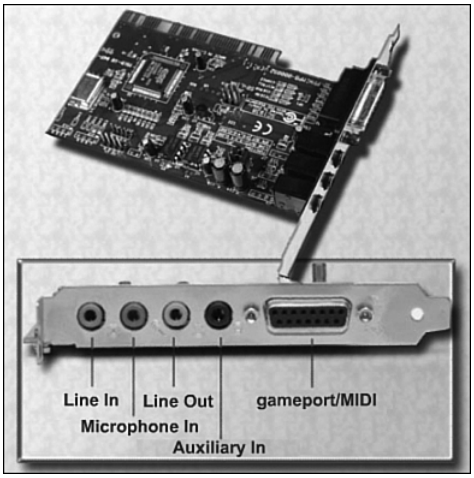
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Audio Ports

An audio port connects audio devices to the computer. The following audio ports are commonly used, as shown in Figure 1-18:

- **Line In** connects to an external source, such as a stereo system.
- **Microphone In** connects to a microphone.
- **Line Out** connects to speakers or headphones.
- **Auxiliary In** is an additional line in.
- **Gameport/MIDI** connects to a joystick or MIDI-interfaced device.

Figure 1-18 Audio Ports



Video Ports and Connectors

A video port connects a monitor cable to a computer. Several video port and connector types exist:

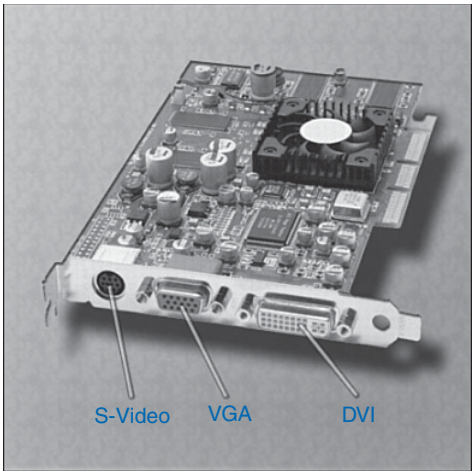
- ***Video Graphics Array (VGA)*** has a three-row 15-pin female connector and provides analog output to a monitor.
- ***Digital Visual Interface (DVI)*** has a 24-pin female connector or a 29-pin female connector and provides compressed digital output to a monitor. DVI-I provides both analog and digital signals. DVI-D provides digital signals only.
- ***High-Definition Multimedia Interface (HDMI)*** has a 19-pin connector and provides digital video and digital audio signals.

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- ***S-Video*** has a four-pin connector and provides analog video signals.
- ***Component/RGB*** has three shielded cables (red, green, and blue) with RCA jacks and provides analog video signals.

Figure 1-19 shows the video ports on a video card.

Figure 1-19 Video Ports



Identify the Names, Purposes, and Characteristics of Input Devices

An input device is used to enter data or instructions into a computer. Here are some examples of input devices:

- Mouse and keyboard
- Digital camera and digital video camera
- Biometric authentication device
- Touch screen
- Scanner

The mouse and keyboard are the two most commonly used input devices. The mouse is used to navigate the graphical user interface (GUI). The keyboard is used to enter text commands that control the computer.

Digital cameras and digital video cameras, shown in Figure 1-20, create images that can be stored on magnetic media. The image is stored as a file that can be displayed, printed, or altered.

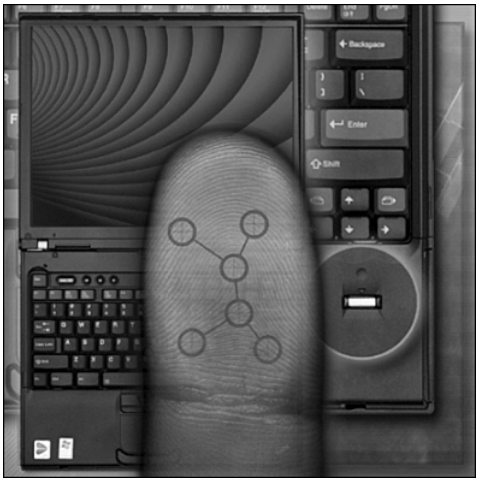
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Figure 1-20 Digital Cameras



Biometric identification uses features that are unique to an individual user, such as fingerprints, voice recognition, or a retinal scan. When combined with ordinary usernames, biometrics guarantees that the authorized person is accessing the data. Figure 1-21 shows a laptop that has a built-in fingerprint scanner.

Figure 1-21 Fingerprint Scanner



A touch screen has a pressure-sensitive transparent panel. The computer receives instructions specific to the place on the screen that the user touches.

A scanner digitizes an image or document. The digitization of the image is stored as a file that can be displayed, printed, or altered. A bar code reader is a type of scanner that reads

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Universal Product Code (UPC) bar codes. It is widely used for pricing and inventory information.

Identify the Names, Purposes, and Characteristics of Output Devices

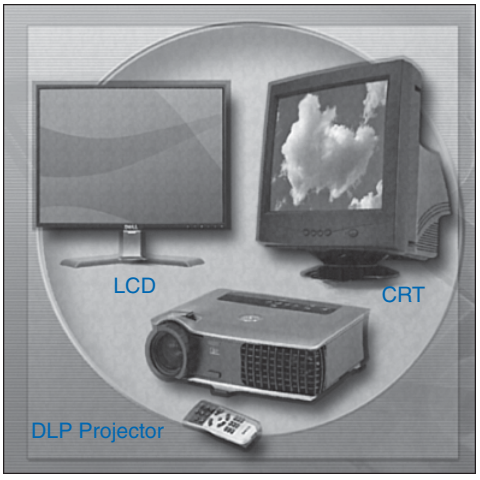
An output device is used to present information to the user from a computer. Here are some examples of output devices:

- Monitors and projectors
- Printers, scanners, and fax machines
- Speakers and headphones

Monitors and Projectors

Monitors and projectors are primary output devices for a computer. Figure 1-22 shows different types of monitors.

Figure 1-22 Types of Monitors



The most important difference between these monitor types is the technology used to create an image:

- ***CRT***: Cathode ray tube monitors are the most common monitor type. Red, green, and blue electron beams move back and forth across the phosphorous-coated screen. The phosphor glows when struck by the electron beam. Areas not struck by the electron beam do not glow. The combination of glowing and nonglowing areas is what creates the image on the screen. Most televisions also use this technology.

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- ***LCD***: Liquid crystal display is commonly used in laptops and some projectors. It consists of two polarizing filters with a liquid crystal solution between them. An electronic current aligns the crystals so that light can either pass through or not pass through. The effect of light passing through in certain areas and not in others is what creates the image. LCD comes in two forms—active matrix and passive matrix. Active matrix is sometimes called thin film transistor (TFT). TFT allows each pixel to be controlled, which creates very sharp color images. Passive matrix is less expensive than active matrix but does not provide the same level of image control. LCD Monitors are becoming the most common type of computer monitor.
- ***DLP***: Digital light processing is another technology that is used in projectors. DLP projectors use a spinning color wheel with a microprocessor-controlled array of mirrors called a digital micromirror device (DMD). Each mirror corresponds to a specific pixel. Each mirror reflects light toward or away from the projector optics. This creates a monochromatic image of up to 1024 shades of gray between white and black. The color wheel then adds the color data to complete the projected color image.

Monitor resolution refers to the level of image detail that can be reproduced. Table 1-9 is a chart of common monitor resolutions.

Table 1-9 Display Resolutions

Display Standard	Linear Pixels (HXV)	Aspect Ratio
CGA	320×200	16:10
EGA	640×350	11:6
VGA	640×480	4:3
WVGA	854×480	16:9
SVGA	800×600	4:3
XGA	1024×768	4:3
WXGA	1280×800	16:10
SXGA	1280×1024	5:4
WSXGA	1600×1024	25:16
UXGA	1600×1200	4:3
HDTV	1920×1080	16:9
WUXGA	1920×1200	16:10
QXGA	2048×1536	4:3
QSXGA	2560×2048	5:4
WQUXGA	3840×2400	16:10

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Higher-resolution settings produce better image quality. Several factors are involved in monitor resolution:

- ***Pixels***: The term pixel is an abbreviation of picture element. Pixels are the tiny dots that comprise a screen. Each pixel consists of red, green, and blue.
- ***Dot pitch***: Dot pitch is the distance between pixels on the screen. A lower dot pitch number produces a better image.
- ***Refresh rate***: The refresh rate is how often per second the image is rebuilt. A higher refresh rate produces a better image and reduces the level of flicker.
- ***Interlaced/noninterlaced***: Interlaced monitors create the image by scanning the screen two times. The first scan covers the odd lines, top to bottom, and the second scan covers the even lines. Noninterlaced monitors create the image by scanning the screen one line at a time from top to bottom. Most CRT monitors today are noninterlaced.
- ***Horizontal Vertical Colors (HVC)***: The number of pixels in a line is the horizontal resolution. The number of lines in a screen is the vertical resolution. The number of colors that can be reproduced is the color resolution.
- ***Aspect ratio***: Aspect ratio is the horizontal-to-vertical measurement of the monitor's viewing area. For example, a 4:3 aspect ratio applies to a viewing area that is 16 inches wide by 12 inches high. A 4:3 aspect ratio also applies to a viewing area that is 24 inches wide by 18 inches high. A viewing area that is 22 inches wide by 12 inches high has an aspect ratio of 11:6.

Monitors have controls for adjusting the image quality. Here are some common monitor settings:

- **Brightness** is the image's intensity.
- **Contrast** is the ratio of light to dark.
- **Position** is the vertical and horizontal location of the image on the screen.
- **Reset** returns the monitor settings to the factory defaults.

Printers, Scanners, and Fax Machines

Printers are output devices that create hard copies of computer files. Some printers specialize in particular applications, such as printing color photographs. Other all-in-one-type printers, such as the one shown in Figure 1-23, are designed to provide multiple services such as printing, fax, and copier functions.

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Figure 1-23 All-in-One Printer



Speakers and Headphones

Speakers and headphones, shown in Figure 1-24, are output devices for audio signals. Most computers have audio support either integrated into the motherboard or on an adapter card. Audio support includes ports that allow input and output of audio signals. The audio card has an amplifier to power headphones and external speakers.

Figure 1-24 Speakers and Headphones



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Explain System Resources and Their Purposes

System resources are used for communication between the CPU and other components in a computer. The three common system resources are

- Interrupt requests (IRQ)
- I/O port addresses
- Direct Memory Access (DMA)

The following sections describe these system resources in greater detail.

Interrupt Requests

Computer components use ***interrupt requests (IRQ)*** to request information from the CPU. The IRQ travels along a wire on the motherboard to the CPU. When the CPU receives an interrupt request, it determines how to fulfill this request. The priority of the request is determined by the IRQ number assigned to that computer component. Older computers had only eight IRQs to assign to devices. Newer computers have 16 IRQs, which are numbered 0 to 15, as shown in Table 1-10. As a general rule, each component in the computer must be assigned a unique IRQ. IRQ conflicts can cause components to stop functioning and even cause the computer to crash. With the numerous components that can be installed in a computer, it is difficult to assign a unique IRQ to every component. Today, most IRQ numbers are assigned automatically with "plug-and-play" operating systems and the implementation of PCI slots, USB ports, and FireWire ports.

Table 1-10 Interrupt Requests (IRQ)

IRQ	Description
IRQ 0	System timer. Reserved for the system. The user cannot change it.
IRQ 1	Keyboard. Reserved for the system. Cannot be altered, even if no keyboard is present or needed.
IRQ 2	Second IRQ controller.
IRQ 3	COM 2 (default), COM 4 (user).
IRQ 4	COM 1 (default), COM 3 (user).
IRQ 5	Sound card (Sound Blaster Pro or later) or LPT2 (user).
IRQ 6	Floppy disk controller.
IRQ 7	LPT1 (parallel port) or sound card (8-bit Sound Blaster and compatible).
IRQ 8	Real-time clock.
IRQ 9	ACPI SCSI or ISA MPU-401.

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IRQ	Description
IRQ 10	Free/open interrupt/available/SCSI.
IRQ 11	Free/open interrupt/available/SCSI.
IRQ 12	PS/2 connector mouse. If no PS/2 connector mouse is used, this can be used for other peripherals.
IRQ 13	Math coprocessor. Cannot be changed.
IRQ 14	Primary IDE. If no primary IDE exists, this can be changed.
IRQ 15	Secondary IDE.

Input/Output (I/O) Port Addresses

Input/output (I/O) port addresses are used to communicate between devices and software. The I/O port address is used to send and receive data for a component. As with IRQs, each component has a unique I/O port assigned. A computer has 65,535 I/O ports, and they are referenced by a hexadecimal address in the range of 0000h to FFFFh. Table 1-11 is a chart of common I/O ports.

Table 1-11 I/O Addresses

I/O Port Addresses (in Hex)	Typical Device or Port Assignment	I/O Port Addresses (in Hex)	Typical Device or Port Assignment	I/O Port Addresses (in Hex)	Typical Device or Port Assignment
000–00f, 081–09F	Direct memory access controller	1F0–1F7	Primary hard-disk controller	3E8–3EF	COM 3 serial port
010–01F, 0A0–0A1	Programmable interrupt controller	200–207	Game port joystick	3F0–3F7	Floppy disk controller
040–043	System timer	220–22F	Sound card	3F6–3F6	PCI primary IDE controller
060–060, 064–064	Keyboard	294–297	PCI bus (data comm)	3F8–3FF	COM1 serial port
061–061	PC speaker	278–27F	LPT 2 or LPT 3	E000–E01F	USB host controller

continues

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Table 1-11 I/O Addresses *continued*

I/O Port Addresses (in Hex)	Typical Device or Port Assignment	I/O Port Addresses (in Hex)	Typical Device or Port Assignment	I/O Port Addresses (in Hex)	Typical Device or Port Assignment
070–071	CMOS/real-time clock	2E8–2EF	COM 4 serial port	E800–E87F	Fast Ethernet adapter
0F0–0FF	Math coprocessor	2F8–2FF	COM 2 serial port	F000–F00F	IDE controller
130–14F	SCSI host adapter	376–376	PCI IDE controller		
170–177	Secondary hard-disk controller	378–37F	LPT1		

Direct Memory Access

High-speed devices use ***Direct Memory Access (DMA)*** channels to communicate directly with the main memory. These channels allow the device to bypass interaction with the CPU and directly store information in memory and retrieve it. Only certain devices can be assigned a DMA channel, such as SCSI host adapters and sound cards. Older computers had only four DMA channels to assign to components. Newer computers have eight DMA channels that are numbered 0 to 7, as shown in Table 1-12.

Table 1-12 DMA Channels

DMA Channel	Default Device	Can Also Be Used For
0	Dynamic RAM memory refresh	
1	Sound card (low DMA setting)	Network cards, SCSI adapters, parallel printing port, and voice modems
2	Floppy disk controller	
3	Available	Network cards, SCSI adapters, parallel printing port, voice modems, and sound card (low DMA setting)
4	Cascade for DMA 0–3	
5	Sound card (high DMA setting)	Network cards, SCSI adapters
6	Available	Network cards, sound card (high DMA setting)
7	Available	Network cards, sound card (high DMA setting)

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Summary

This chapter introduced the IT industry, options for training and employment, and some of the industry-standard certifications. This chapter also covered the components that comprise a PC system. Much of the content in this chapter will help you throughout this course:

- Information technology encompasses the use of computers, network hardware, and software to process, store, transmit, and retrieve information.
- A PC system consists of hardware components and software applications.
- You must carefully choose the computer case and power supply to support the hardware inside the case and allow for the addition of components.
- A computer's internal components are selected for specific features and functions. All internal components must be compatible with the motherboard.
- You should use the correct type of ports and cables when connecting devices.
- Typical input devices include the keyboard, mouse, touch screen, and digital cameras.
- Typical output devices include monitors, printers, and speakers.
- System resources must be assigned to computer components. System resources include IRQs, I/O port addresses, and DMAs.

Summary of Exercises

This is a summary of the worksheets associated with this chapter.



Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Worksheet 1.1.2: Job Opportunities

Worksheet 1.4.7: Research Computer Components

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

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1. How many FireWire devices can a single FireWire port support?

   A. 12
   B. 25
   C. 32
   D. 54
   E. 63
   F. 127

2. Which type of memory transfers data twice as fast as SDRAM and increases performance by transferring data twice per cycle?

   A. DDR-SDRAM
   B. DRAM2
   C. D-SDRAM
   D. ROM

3. Which type of video connector has a 24-pin or 29-pin female connector and provides compressed digital output to a monitor?

   A. AAV
   B. DVI
   C. HDMI
   D. RCA
   E. VGA

4. How many universal serial bus (USB) devices can be connected to a USB port?

   A. 256
   B. 127
   C. 64
   D. 128

5. What is the maximum data speed of high-speed USB 2.0?

   A. 1.5 Mbps
   B. 12 Mbps
   C. 380 Mbps
   D. 480 Mbps
   E. 480 Gbps
   F. 840 Gbps

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6. Which IEEE standard defines the FireWire technology?

   A. 1284
   B. 1394
   C. 1451
   D. 1539

7. What is the maximum data rate supported by the IEEE 1394a standard?

   A. 200 Mbps
   B. 380 Mbps
   C. 400 Mbps
   D. 800 Mbps
   E. 900 Mbps

8. What is the purpose of a heat sink installed on a processor?

   A. To set the processor voltage
   B. To cool the processor
   C. To set the processor speed
   D. To ground the processor

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CHAPTER 2

Safe Lab Procedures and Tool Use

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- What are the safe working conditions and procedures?
- What tools and software are used with personal computer components and what is their purpose?
- What is proper tool use?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

electrostatic discharge (ESD) *page xx*

antistatic wrist straps *page xx*

current *page xx*

power fluctuations *page xx*

blackout *page xx*

brownout *page xx*

noise *page xx*

spike *page xx*

power surge *page xx*

power protection devices *page xx*

surge suppressor *page xx*

uninterruptible power supply (UPS) *page xx*

standby power supply (SPS) *page xx*

material safety data sheet (MSDS) *page xx*

Occupational Safety and Health Administration (OSHA) *page xx*

Chemicals Hazard Information and Packaging for Supply Regulations 2002 (CHIP3) *page xx*

antistatic mat *page xx*

hand tools *page xx*

flat head screwdriver *page xx*

Phillips head screwdriver *page xx*

hex driver *page xx*

needle-nose pliers *page xx*

tweezers *page xx*

part retriever *page xx*

cleaning tools *page xx*

diagnostic tools *page xx*

disk management tools *page xx*

Fdisk *page xx*

Format *page xx*

Scandisk *page xx*

continues

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continued

Defrag page xx

Disk Cleanup page xx

Disk Management page xx

protection software tools page xx

personal reference tools page xx

workbench page xx

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This chapter covers basic safety practices for the workplace, hardware and software tools, and the disposal of hazardous materials. Safety guidelines help protect individuals from accidents and injury, equipment from damage, and the environment from contamination by discarded materials. Always stay alert to situations that could result in injury or damage to equipment. Always watch for these signs and take the appropriate action according to the warning given.

Identify Safe Working Conditions and Procedures

It is essential to maintain safe working conditions to prevent accidents and injury to any person or damage to any object in a work area. New staff and visitors must be informed of the appropriate safety procedures. Any transgression of the procedures must be reported.

As a computer user or a technician, you should be aware of all possible dangers. A safe workspace is clean, organized, and well lit.

Follow proper procedures for handling computer equipment. Failure to follow the prescribed safety procedures could result in fines, criminal convictions, damage to equipment, claims for damage from the owner of the property and data, injury, or death.

The proper disposal or recycling of hazardous computer components is a global issue. Make sure to follow regulations that govern how to dispose of specific items. When an organization violates these regulations, there can be legal consequences.

After completing the following sections, you will meet these objectives:

- Identify safety procedures and potential hazards for users and technicians
- Identify safety procedures to protect equipment from damage and data loss
- Identify correct disposal procedures to protect the environment from contamination

Identify Safety Procedures and Potential Hazards for Users and Technicians

Safety in the lab and in the workplace is an important issue when working on computers and other electrical devices. General safety guidelines and fire safety guidelines protect the technician and the equipment.

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General Safety Guidelines

Follow the basic safety guidelines to prevent cuts, burns, electrical shock, and damage to eyesight. As a best practice, make sure that a fire extinguisher and first aid kit are available in case of fire or injury. Here are some general safety guidelines:

- Remove your watch or any other jewelry and secure loose clothing.
- Turn off the power and unplug equipment before opening the case and performing service.
- Cover any sharp edges inside the computer case with tape.
- Never open a power supply or a monitor.
- Do not touch areas in printers that are hot or use high voltage.
- Know where the fire extinguisher is located and how to use it.
- Know where the first aid kit is located.
- Keep food and drinks out of your workspace.
- Keep your workspace clean and free of clutter.
- Lift heavy objects with your legs to avoid back injury.

Caution

Power supplies and monitors contain very high voltage. Do not wear the antistatic wrist strap when replacing power supplies or monitors. Also, some printer parts might become very hot when in use, and other parts can contain very high voltages. Make sure that the printer has had time to cool before making the repair. Check the printer manual for locations of various components that can contain high voltages. Some components might retain high voltages even after the printer is turned off.

Fire Safety Guidelines

Follow fire safety guidelines to protect equipment and lives. Turn off and unplug the computer before beginning a repair to avoid damage to the computer or a shock to the technician.

Fire can spread rapidly and be very costly. Proper use of a fire extinguisher can prevent a small fire from getting out of control. When working with computer components, always consider the possibility of an accidental fire and know how to react. If there is a fire, you should follow these safety procedures:

- Never fight a fire that is out of control or not contained.
- Always have a planned fire escape route before beginning any work.
- Get out of the building quickly.
- Contact emergency services for help.

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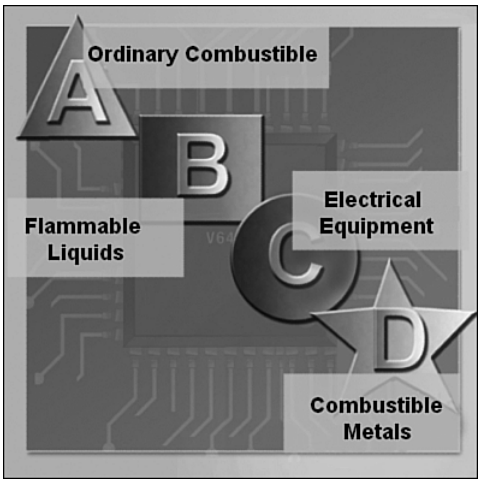
Caution

Be sure to read the instructions on the fire extinguishers in your workplace before you have to use them. Safety training might be available in your organization.

In the United States, there are four classifications for fire extinguishers. A different letter, color, and shape identify each fire extinguisher classification, as shown in Figure 2-1. Each fire extinguisher has specific chemicals to fight each specific type of fire as follows:

- **Class A**: Effective for fires burning paper, wood, plastics, and cardboard materials
- **Class B**: Effective for fires burning gasoline, kerosene, or organic solvents
- **Class C**: Effective for fires burning electrical equipment
- **Class D**: Effective for fires burning combustible metals, such as magnesium and titanium.

Figure 2-1 Fire Extinguisher Classifications



Fire extinguisher classifications might vary by country.

It is important to know how to use a fire extinguisher. Use the memory aid P-A-S-S to help you remember the basic rules of fire extinguisher operation:

- **P**: Pull the pin.
- **A**: Aim at the base of the fire, not at the flames.
- **S**: Squeeze the lever.
- **S**: Sweep the nozzle from side to side.

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Identify Safety Procedures to Protect Equipment from Damage and Data from Loss

Static electricity is the buildup of an electric charge resting on a surface. This buildup and sudden release of energy, called ***electrostatic discharge (ESD)***, can be destructive to the electronics in a computer system.

ESD, harsh climates, and poor-quality sources of electricity can cause damage to computer equipment. Follow the proper handling guidelines, be aware of environmental issues, and use equipment that stabilizes power to prevent equipment damage and data loss.

At least 3000 volts of static electricity must be built up before you can feel the ESD, but less than 30 volts of static electricity could damage a computer component. For example, static electricity can build up on a person walking across a carpeted floor. When the person touches another person, they both receive a shock. If the discharge causes pain or makes a noise, the charge was probably above 10,000 volts.

ESD Protection Recommendations

ESD can cause permanent damage to electrical components. Follow these recommendations to help prevent ESD damage:

- Keep all components in antistatic bags until you are ready to install them.
- Use grounded mats on workbenches and on the work area floor.
- Use ***antistatic wrist straps*** when working on computers.
- Avoid working on carpeted areas if possible.

Climate also affects risks when working with computer equipment. Consider the following recommendations:

- If the environment temperature is too high, equipment can overheat.
- If the humidity level is too low, the chance of ESD increases.
- If the humidity level is too high, equipment can suffer from moisture damage.

Table 2-1 shows how environmental conditions affect the risks of ESD.

Table 2-1 ESD Probability

Conditions	ESD Probability
Cool and dry	High
Warm and humid	Low

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Power Fluctuation Types

Voltage is the force that moves electrons. The potential difference between two points in a circuit is what causes electricity to move. The movement of electrons is called ***current***. Computer circuits need voltage and current to operate electronic components. When the voltage in a computer is not accurate or steady, computer components might not operate correctly. Unsteady voltages are called ***power fluctuations***.

The following types of AC power fluctuations can cause data loss or hardware failure:

- ***Blackout***: Loss of AC power. A blown fuse, damaged transformer, or downed power line can cause a blackout.
- ***Brownout***: Reduced voltage level of AC power that lasts for a period of time. Brownouts occur when the power line voltage drops below 80 percent of the normal voltage level. Overloading electrical circuits can cause a brownout.
- ***Noise***: Interference from generators and lightning. Noise results in unclean power, which can cause errors in a computer system.
- ***Spike***: Sudden increase in voltage that lasts for a very short period and exceeds 100 percent of the normal voltage on a line. Spikes can be caused by lightning strikes, but can also occur when the electrical system comes back on after a blackout.
- ***Power surge***: Dramatic increase in voltage above the normal flow of electrical current. A power surge lasts for a few nanoseconds, or a few billionths of a second.

Power Protection Devices

To help shield against power issues, use ***power protection devices*** to protect the data and computer equipment:

- ***Surge suppressor***: Helps protect against damage from surges and spikes. A surge suppressor diverts extra electrical voltage on the line to the ground.
- ***Uninterruptible power supply (UPS)***: Helps protect against potential electrical power problems by supplying electrical power to a computer or other device. The battery is constantly recharging while the UPS is connected to a power source. The UPS is able to supply a consistent quality of power when brownouts and blackouts occur. Many UPS devices are able to communicate directly with the operating system on a computer. This allows the UPS to safely shut down the computer and save data prior to the UPS losing all electrical power.
- ***Standby power supply (SPS)***: Helps protect against potential electrical power problems by providing a backup battery to supply power when the incoming voltage drops below the normal level. The battery is on standby during normal operation. When the voltage decreases, the battery provides DC power to a power inverter, which converts it to AC power for the computer. The problem with this device is the time it takes to switch over

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to the battery. If the switching device fails, the battery will not be able to supply power to the computer.

Figure 2-2 shows some examples of surge suppressors, UPSs, and SPS devices.

Figure 2-2 Surge Suppressors and UPS Devices



Caution

Never plug a printer into a UPS device because this can overheat the printer motor.

Identify Safety Procedures to Protect the Environment from Contamination

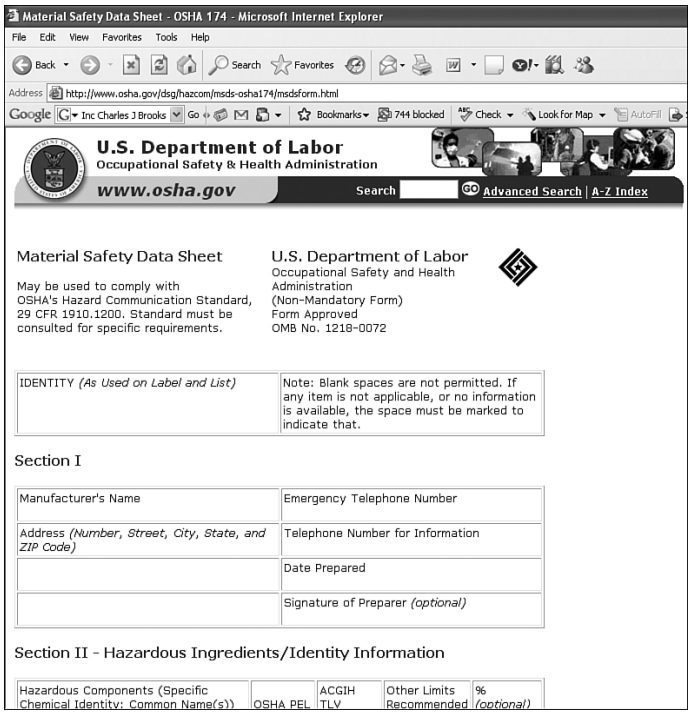
Computers and peripherals can contain materials that are harmful to the environment. Waste materials are listed as hazardous because they are known to be harmful and need to be disposed of properly. Also called toxic waste, hazardous materials typically contain high concentrations of heavy metals such as cadmium, lead, or mercury. Always contact the local recycling or waste removal authorities in your community for information about disposal procedures and disposal services.

Material Safety Data Sheet

A ***material safety data sheet (MSDS)*** is a fact sheet that summarizes information about material identification, including hazardous ingredients that can affect personal health, fire hazards, and first aid requirements. As Figure 2-3 shows, the MSDS contains chemical reactivity and incompatibility information that includes spill, leak, and disposal procedures. It also includes protective measures for the safe handling and storage of materials.

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Figure 2-3 MSDS



To determine whether a material used in computer repairs or preventive maintenance is classified as hazardous, consult the manufacturer's MSDS. In the United States, the ***Occupational Safety and Health Administration (OSHA)*** requires that all hazardous materials must be accompanied by an MSDS when transferred to a new owner. The MSDS information included with products purchased for computer repairs or maintenance can be relevant to computer technicians. OSHA also requires that employees be informed about the materials that they are working with and be provided with material safety information. In the United Kingdom, ***Chemicals Hazard Information and Packaging for Supply Regulations 2002 (CHIP3)*** oversees the handling of hazardous materials. CHIP3 requires chemical suppliers to safely package and transport dangerous chemicals and to include a data sheet with the product.

The MSDS is valuable in determining how to dispose of any potentially hazardous materials in the safest manner. Always check local regulations concerning acceptable disposal methods before disposing of any electronic equipment.

Note

If you are working outside the United States, make sure that you are familiar with the organization that governs the use of hazardous chemicals and what that organization mandates regarding compliance.

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The MSDS contains valuable information such as

- The name of the material
- The physical properties of the material
- Any hazardous ingredients contained in the material
- Reactivity data, such as fire and explosion data
- Procedures for spills or leaks
- Special precautions
- Health hazards
- Special protection requirements

Before discarding a computer or any of its components, it is necessary to consider safe disposal of each separate component.

Proper Disposal of Batteries

Batteries often contain rare-earth metals that can be harmful to the environment. Batteries from portable computer systems can contain lead, cadmium, lithium, alkaline manganese, and mercury. These metals do not decay and will remain in the environment for many years. Mercury is commonly used in the manufacturing of batteries and is extremely toxic to humans.

Recycling batteries should be a standard practice for a technician. All batteries, including lithium-ion, nickel-cadmium, nickel-metal hydride, and lead-acid, are subject to disposal procedures that comply with local environmental regulations.

Proper Disposal of Monitors or CRTs

Always handle monitors and cathode ray tubes (CRT) with care. Monitors and CRTs store a potentially lethal voltage, even after being disconnected from a power source. CRTs contain glass, metal, plastics, lead, barium, and rare-earth metals. According to the U.S. Environmental Protection Agency (EPA), CRTs can contain approximately 4 lb. (1.8 kg) of lead. Monitors must be disposed of in compliance with environmental regulations.

Proper Disposal of Toner Kits, Cartridges, and Developers

Used printer toner kits and printer cartridges can be destructive to the environment and must be disposed of properly or recycled. Some toner cartridge suppliers and manufacturers will also take back empty cartridges for refilling. There are also companies that specialize in refilling empty cartridges. Kits to refill inkjet printer cartridges are available, but are not recommended. The ink can leak into the printer, causing irreversible damage. This can be especially costly because using refilled inkjet cartridges can void the inkjet printer warranty.

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Proper Disposal of Chemical Solvents and Aerosol Cans

The chemicals and solvents used to clean computers can be a source of environmental problems when not disposed of properly. Contact the local sanitation company to learn how and where to dispose of these chemicals. Never dump chemicals or solvents down a sink or dispose of them in any drain that connects to public sewers.

The cans or bottles that solvents and other cleaning supplies come in must be handled carefully. Make sure that they are identified and treated as special hazardous waste. For example, some aerosol cans can explode when exposed to heat if the contents are not completely used.

Identify Tools and Software Used with Personal Computer Components and Know Their Purpose

For every tool there is the right job, and for every job there is the right tool. Ensure that you are familiar with the correct use of each tool and that the right tool is used for the current task. This will reduce the chances of damage or injury. Skilled use of tools and software makes the job less difficult and ensures that tasks are performed properly and safely. Figure 2-4 shows a sample tool kit used to install, connect, remove, and repair PC components.

Figure 2-4 Computer Tools



In addition to hardware tools, software tools are also available that help diagnose problems and determine which computer device is not functioning correctly.

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A technician must document all repairs and computer problems. The documentation can then be used as a reference for future problems or for other technicians who might not have encountered the problem before. The documents might be paper based, but electronic forms can be easily searched for specific problems.

After completing the following sections, you will meet these objectives:

- Identify hardware tools and their purpose
- Identify software tools and their purpose
- Identify organizational tools and their purpose

Identify Hardware Tools and Their Purpose

A tool kit should contain all the tools necessary to complete hardware repairs. Using the wrong tool for a job might lead to bodily injuries or result in equipment damage. As you gain experience, you will learn which tools to have available for different types of jobs. Hardware tools are grouped into the following four categories:

- ESD tools
- Hand tools
- Cleaning tools
- Diagnostic tools

ESD Tools

There are two common ESD tools:

- **Antistatic wrist strap**: Protects computer equipment from ESD damage when grounded to a computer chassis.
- ***Antistatic mat***: Used to stand on or to place hardware on to prevent static electricity from building up, thereby protecting the equipment from ESD damage.

Hand Tools

Most tools used in the computer assembly process are small ***hand tools***. They are available individually or as part of a computer repair tool kit. The correct tools can save time and help you avoid damaging the equipment. Tool kits range widely in size, quality, and price. The list that follows describes the small hand tools that you will most commonly use:

- ***Flat head screwdriver***: Used to loosen or tighten slotted screws.
- ***Phillips head screwdriver***: Used to tighten or loosen cross-head screws.
- **Torx screwdriver**: Used to tighten or loosen screws that have a star-like depression on the top, a feature that is mainly found on laptops.

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- ***Hex driver***: Sometimes called a nut driver, this tool is used to tighten nuts in the same way that a screwdriver tightens screws.
- ***Needle-nose pliers***: Used to hold small parts.
- **Wire cutters**: Used to strip and cut wires.
- ***Tweezers***: Used to manipulate small parts.
- ***Part retriever***: Used to retrieve parts from locations that are too small for your hand to fit in.
- **Flashlight**: Used to illuminate areas that you cannot see well.

Cleaning Tools

The appropriate ***cleaning tools*** are essential when maintaining or repairing computers. These tools will ensure that computer components are cleaned correctly. The list that follows describes the cleaning tools that you will most commonly use:

- **Soft sloth**: Used to clean different computer components without scratching or leaving debris.
- **Compressed air**: Used to blow away dust and debris from different computer parts without touching the components.
- **Cable ties**: Used to bundle cables neatly inside and outside of a computer.
- **Parts organizer**: Used to hold screws, jumpers, fasteners, and other small parts to prevent them from getting mixed together.

Diagnostic Tools

To test hardware, you will use the following ***diagnostic tools***:

- **Digital multimeter**: Used to test the integrity of circuits and the quality of electricity in computer components.
- **Loopback adapter**: Used to test the basic functionality of computer ports.

Identify Software Tools and Their Purpose

A technician must be able to use a range of software tools to help diagnose problems, maintain hardware, and protect the data stored on a computer. The sections that follow describe the various disk management tools and protection software tools that you will encounter.

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Disk Management Tools

You must be able to identify which software to use in different situations. ***Disk management tools*** help detect and correct disk errors, prepare a disk for data storage, and remove unwanted files.

Disk management software includes the following:

- ***Fdisk***: A command-line tool used to create and delete partitions on a hard drive and set active, or boot, partitions
- ***Format***: Used to prepare a hard drive to store information
- ***Scandisk*** **or Chkdsk**: Used to check the integrity of files and folders on a hard drive by scanning the disk surface for physical errors
- ***Defrag***: Used to optimize space on a hard drive to allow faster access to programs and data
- ***Disk Cleanup***: Used to clear space on a hard drive by searching for files that can be safely deleted
- ***Disk Management***: Used to manage hard drives and partitions, initialize disks, create partitions, and format partitions

Use the Windows XP boot disk for troubleshooting and repairing corrupted files. The Windows XP boot disk is designed to repair Windows system files, restore damaged or lost files, and reinstall the operating system. Third-party software tools are available to assist in troubleshooting problems.

Protection Software Tools

Each year, viruses, spyware, and other types of malicious attacks infect millions of computers. These malicious attacks can damage an operating system, application, and data. Computers that have been infected can experience hardware performance problems or component failure.

To protect data and the integrity of the operating system and hardware, you should use software designed to guard against attacks and to clean out malicious programs.

Here is a list of various types of software used to protect hardware and data. Examples of ***protection software tools*** include the following:

- **Windows XP Security Center**: Allows you to check the status of essential security settings on the computer. The Security Center continuously checks to make sure that the software firewall and antivirus programs are running. It also ensures that automatic updates are set to download and install automatically.
- **Antivirus software**: Protects a computer against virus attacks that can infect other computers.

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- **Spyware remover**: Protects against software that sends information about web surfing habits to an attacker. Spyware can be installed without the knowledge or consent of the user.
- **Firewall**: A program that runs continuously to protect against unauthorized communications to and from your computer.



Worksheet 2.2.2: Diagnostic Software

In this worksheet, you will use the Internet, a newspaper, or a local store to gather information about a hard drive diagnostic program. Be prepared to discuss the diagnostic software you researched. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can complete this worksheet now or wait to do so until the end of the chapter.

Identify Organizational Tools and Their Purpose

It is important that a technician document all services and repairs. These documents need to be stored centrally and made available to all other technicians. The documentation can then be used as reference material for similar problems that are encountered in the future. Good customer service includes providing the customer with a detailed description of the problem and the solution.

Personal Reference Tools

Personal reference tools include troubleshooting guides, manufacturers' manuals, quick reference guides, and a repair journal. In addition to an invoice, a technician keeps a journal of upgrades and repairs. The documentation in the journal should include descriptions of the problem, possible solutions that have been tried to correct the problem, and the steps taken to repair the problem. Be sure to note any configuration changes made to the equipment and any replacement parts used in the repair. This documentation will be valuable when you encounter similar situations in the future:

- **Notes**: Make notes as you go through the investigation and repair process. These notes will help you to make sure that you do not repeat any previous steps and will help you to determine what steps to take next.
- **Journal**: Document the upgrades and repairs that you perform. The documentation should include descriptions of the problem, possible solutions that have been tried to correct the problem, and the steps taken to repair the problem. Be sure to note any configuration changes made to the equipment and any replacement parts used in the repair. Your journal, along with your notes, can be valuable when you encounter similar situations in the future.

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- **History of repairs**: Make a detailed list of problems and repairs, including the date, replacement parts, and customer information. The history allows a technician to determine what work has been performed on a computer in the past.

Note

It can be helpful to keep an electronic journal stored on a computer for later troubleshooting.

Internet Reference Tools

The Internet is an excellent source of information about specific hardware problems and possible solutions. Examples of Internet reference tools include the following:

- Internet search engines
- Newsgroups
- Manufacturer FAQs
- Online computer manuals
- Online forums and chat sessions
- Technical websites

Miscellaneous Tools

With experience, you will discover many additional items to add to the tool kit. Figure 2-5 shows how a roll of masking tape can be used to label parts that have been removed from a computer.

Figure 2-5 Labeled Computer Parts

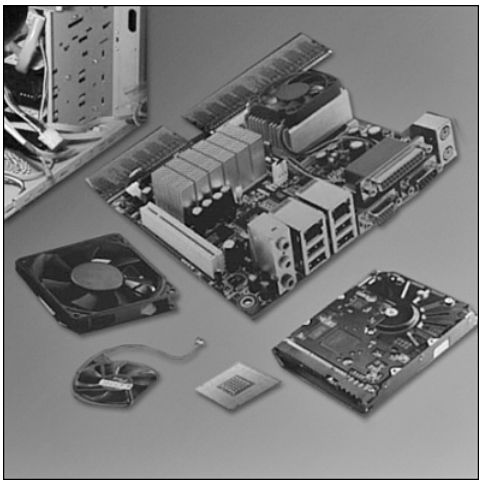


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A working computer is also a valuable resource to take with you on computer repairs in the field. A working computer can be used to research information, download tools or drivers, or communicate with other technicians.

Figure 2-6 shows the types of computer replacement parts to include in a tool kit. Make sure that the parts are in good working order before you use them. Using known good working components to replace possible bad ones in computers will help you quickly determine which component might not be working properly. You should store components in an antistatic bag prior to installation, as shown in Figure 2-7.

Figure 2-6 Replacement Computer Parts



Lab 2.3.4: Computer Disassembly

In this lab, you will disassemble a computer using safe lab procedures and the proper tools. Use extreme care and follow all safety procedures. Familiarize yourself with the tools you will be using in this lab. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

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Figure 2-7 Store Replacement Computer Parts in an Antistatic Bag



Implement Proper Tool Use

Safety in the workplace is everyone's responsibility. For computer repairs, always use the correct tool for the job. The correct tool will make the job easier to complete. You are much less likely to injure yourself or damage components when using the proper tool for the job.

Before cleaning or repairing equipment, check to make sure that your tools are in good condition. Clean, repair, or replace any items that are not functioning adequately.

After completing the following sections, you will meet these objectives:

- Demonstrate proper use of an antistatic wrist strap
- Demonstrate proper use of an antistatic mat
- Demonstrate proper use of various hand tools
- Demonstrate proper use of cleaning materials

Demonstrate Proper Use of an Antistatic Wrist Strap

As discussed previously, an example of ESD is the small shock that someone receives when you walk across a carpeted room and touch a doorknob. Although the small shock is harm-

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less to you, the same electrical charge passing from you to a computer can damage its components. Wearing an antistatic wrist strap can prevent ESD damage to computer components.

The purpose of an antistatic wrist strap is to equalize the electrical charge between you and the equipment. The antistatic wrist strap is a conductor that connects your body to the equipment that you are working on. When static electricity builds in your body, the connection made by the wrist strap to the equipment, or ground, channels the electricity through the wire that connects the strap.

As shown in Figure 2-8, the wrist strap has two parts and is easy to wear:

1. Wrap the strap around your wrist and secure it using the snap or Velcro. The metal on the back of the wrist strap must remain in contact with the skin at all times.
2. Snap the connector on the end of the wire to the wrist strap and connect the other end either to the equipment or to the same grounding point that the antistatic mat is connected to. The metal skeleton of the case is a good place to connect the wire. When connecting the wire to equipment you are working on, choose an unpainted metal surface. A painted surface does not conduct the electricity as well as unpainted metal.

Figure 2-8 Antistatic Wrist Strap



Note

Attach the wire on the same side of the equipment as the arm that is wearing the antistatic wrist strap. This will help to keep the wire out of the way while you are working.

Although wearing a wrist strap will help to prevent ESD, you can further reduce the risks by not wearing clothing made of silk, polyester, or wool. These fabrics are more likely to generate a static charge.

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Note

Technicians should roll up their sleeves and tuck in their shirts to prevent interference from clothes. Also, ensure that earrings, necklaces, and other loose jewelry are properly secured.

Caution

Never wear an antistatic wrist strap if you are repairing a monitor or CRT.

Demonstrate Proper Use of an Antistatic Mat

You might not always have the option to work on a computer in a properly equipped workspace. If you can control the environment, try to set up your workspace away from carpeted areas. Carpets can cause the buildup of electrostatic charges. If you cannot avoid the carpeting, take great care to ground yourself to the unpainted portion of the computer case that you are working on before touching any components.

Antistatic Mat

An antistatic mat is slightly conductive. It works by drawing static electricity away from a component and transferring it safely from equipment to a grounding point, as shown in Figure 2-9.

Figure 2-9 Antistatic Mat



Lay the mat on the workspace next to or under the computer case. Clip the mat to the case to provide a grounded surface on which you can place parts as you remove them from the system. Reducing the potential for ESD reduces the likelihood of damage to delicate circuits or components.

Note

Always handle components by the edges.

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Workbench

When you are working at a ***workbench***, ground the workbench and the antistatic floor mat. By standing on the mat and wearing the wrist strap, your body has the same charge as the equipment. Correct use of an antistatic mat and a wrist strap will prevent an electrical charge from causing damage to computer components.

Demonstrate Proper Use of Various Hand Tools

A technician needs to be able to properly use each tool in the tool kit. This topic covers many of the various hand tools used when repairing computers.

Screws

Match each screw with the proper screwdriver. Place the tip of the screwdriver on the head of the screw. Turn the screwdriver clockwise to tighten the screw and counterclockwise to loosen the screw.

Screws can become stripped if you overtighten them with a screwdriver. A stripped screw, shown in Figure 2-10, can get stuck in the screw hole, or it might not tighten firmly. Discard stripped screws.

Figure 2-10 Stripped Screw



Flat Head Screwdriver

Use a flat head screwdriver when you are working with a slotted screw. Do not use a flat head screwdriver to remove a Phillips head screw. Also, do not use a screwdriver as a pry bar. If any component requires prying, you might have overlooked a clip or latch that can be holding the component in place.

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Caution

If excessive force is needed to remove or add a component, something is probably wrong. Take a second look to make sure that you have not missed something that is holding the component in place. Check the device manual or diagram for additional information.

Phillips Head Screwdriver

Use a Phillips head screwdriver with crosshead screws. Do not use this type of screwdriver to puncture anything. This will damage the head of the screwdriver.

Hex Drivers

As shown in Figure 2-11, use a hex driver to loosen and tighten bolts that have a hexagonal (six-sided) head. Hex bolts should not be overtightened because the threads of the bolts can be stripped. Do not use a hex driver that is too large for the bolt that you are turning.

Figure 2-11 Hex Driver



Caution

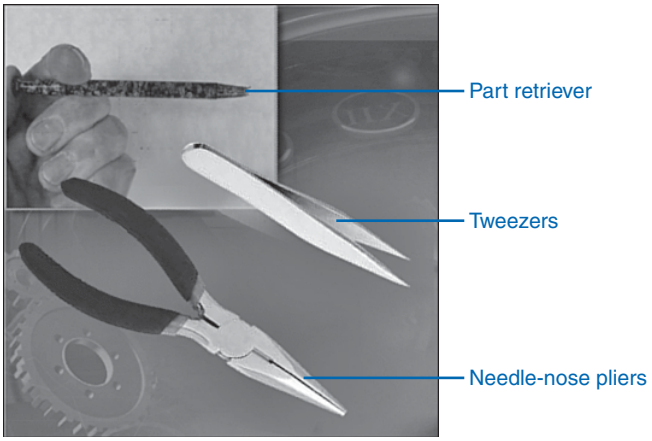
Some tools are magnetized. When working around electronic devices, be sure that the tools you are using have not been magnetized. Magnetic fields can be harmful to data stored on magnetic media. Test your tool by touching the tool with a screw. If the screw sticks to the tool, do not use the tool.

Part Retriever, Needle-Nose Pliers, or Tweezers

As shown in Figure 2-12, the part retriever, needle-nose pliers, or tweezers can be used to place and retrieve parts that can be hard to reach with your fingers. Do not scratch or hit any components when using these tools.

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Figure 2-12 Component Retrieving Tools



Caution

Pencils should not be used inside the computer to change the setting of switches or to pry off jumpers. The pencil lead can act as a conductor and can damage the computer components.

Demonstrate Proper Use of Cleaning Materials

Keeping computers clean inside and out is a vital part of a maintenance program. Dirt can cause problems with the physical operation of fans, buttons, and other mechanical components. On electrical components, an excessive buildup of dust will act like an insulator and trap the heat. This insulation will impair the ability of heat sinks and cooling fans to keep components cool, causing chips and circuits to overheat and fail.

Caution

Before cleaning any device, turn it off and unplug the device from the power source.

Cleaning Computer Cases and Monitors

Clean computer cases and the outside of monitors with a mild cleaning solution on a damp, lint-free cloth. Mix one drop of dishwashing liquid with four ounces of water to create the cleaning solution. If any water drips inside the case, allow enough time for the liquid to dry before powering on the computer.

Cleaning LCD Screens

Do not use ammoniated glass cleaners or any other solution on an LCD screen unless the cleaner is specifically designed for the purpose. Harsh chemicals will damage the coating

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on the screen. There is no glass protecting these screens, so be gentle when cleaning them and do not press firmly on the screen.

Cleaning CRT Screens

To clean the screens of CRT monitors, dampen a soft, clean, lint-free cloth with distilled water and wipe the screen from top to bottom. Do not spray the glass cleaner directly onto the display.

Note

Use a soft, dry cloth to wipe the screen and remove any streaking after you have cleaned the monitor.

Clean dusty components with a can of compressed air. Compressed air does not cause electrostatic buildup on components. Make sure that you are either outside or in a well-ventilated area before blowing the dust out of the computer. A best practice is to wear a dust mask to make sure that you do not breathe in the dust particles. You might need more than one can for larger jobs. As you use a can of compressed air, the force of the air will diminish. Alternate using each can of air so that each can has time to recharge.

Note

Blow out the dust using short bursts from the can. Never tip or use the compressed air can upside down. Do not allow the fan blades to spin from the force of the compressed air. Hold the fan in place. Fan motors can be ruined from spinning when the motor is not turned on. Do not allow the tip of the nozzle to touch the components because ESD can form at the nozzle tip.

Cleaning Component Contacts

Clean the contacts on components with isopropyl alcohol. Do not use rubbing alcohol. Rubbing alcohol contains impurities that can damage contacts. Make sure that the contacts do not collect lint from the cloth or cotton swab. Blow any lint off the contacts with compressed air before reinstallation.

Cleaning Keyboards

Clean a desktop keyboard with compressed air or a small, handheld vacuum cleaner with a brush attachment.

Caution

Never use a vacuum cleaner inside a computer case or on a laptop keyboard. The plastic parts of the vacuum cleaner can build static electricity and discharge to the components. Use compressed air to clean a laptop keyboard.

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Cleaning a Mouse

Use glass cleaner and a soft cloth to clean the outside of the mouse. Do not spray glass cleaner directly on the mouse. If cleaning a ball mouse, you can remove the ball and clean it with glass cleaner and a soft cloth. Wipe the rollers clean inside the mouse with the same cloth. You might need to use a nail file to clean the rollers on the mouse. Do not spray liquids inside the mouse.

The following list documents the computer items that you should clean and the cleaning materials you should use in each case:

- **Computer case and outside of monitor**: Mild cleaning solution of dishwashing liquid and water
- **LCD screen**: Mild cleaning solution of dishwashing liquid and water
- **CRT screen**: Glass cleaner and soft cloth (spray on the cloth, not on the screen)
- **Heat sink**: Compressed air
- **RAM stick**: Isopropyl alcohol and some Q-tips
- **Keyboard**: Handheld vacuum cleaner with a brush attachment
- **Mouse**: Glass cleaner and soft cloth (spray on the cloth, not on the mouse)

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Summary

This chapter discussed safe lab procedures, correct tool usage, and the proper disposal of computer components and supplies. You have familiarized yourself in the lab with many of the tools used to build, service, and clean computer and electronic components. You have also learned the importance of organizational tools and found out how these tools help you work more efficiently.

The following are some of the important concepts to remember from this chapter:

- Work in a safe manner to protect both users and equipment.
- Follow all safety guidelines to prevent injuries to yourself and to others.
- Know how to protect equipment from ESD damage.
- Know about and be able to prevent power issues that can cause equipment damage or data loss.
- Know which products and supplies require special disposal procedures.
- Familiarize yourself with MSDSs for both safety issues and disposal restrictions to help protect the environment.
- Be able to use the correct tools for the task.
- Know how to clean components safely.
- Use organizational tools during computer repairs.

Summary of Exercises

This is a summary of the Labs, Worksheets, Remote Technician exercises, Class Discussions, Virtual Desktop activities, and Virtual Laptop activities associated with this chapter.



Labs

The following lab covers material from this chapter. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).



Lab 2.3.4: Computer Disassembly

Worksheets

The following worksheet covers material from this chapter. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Worksheet 2.2.2: Diagnostic Software

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Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. What class of fire extinguisher is used to extinguish electrical equipment fires?

   A. Class A
   B. Class B
   C. Class C
   D. Class D

2. Which of the following is a fact sheet that summarizes information about material identification, including hazardous ingredients that can affect personal health, fire hazards, and first aid requirements?

   A. ESD
   B. MSDS
   C. OSHA
   D. UPS

3. Which of the following can cause permanent damage to electrical components if you do not use proper tools and safety procedures?

   A. ESD
   B. UPS
   C. MSDS
   D. OSHA

4. What is the minimum level of electrostatic discharge that a person can normally feel?

   A. 5 volts
   B. 1000 volts
   C. 3000 volts
   D. 10,000 volts

5. Which recommendation should be followed first when a fire in the workplace is out of control?

   A. Try to use the elevators to get to the lowest floor faster.
   B. Get out of the room or building and contact emergency services for help.
   C. Use the company water system to stop the fire from extending to other areas.
   D. Try to control the fire with proper extinguishers.

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6. Which of the following tools are recommended for cleaning a PC? (Choose two.)

A. Antibacterial spray
B. Compressed air
C. Mild abrasive detergent
D. Nylon brush
E. Rubbing alcohol
F. Soft cloth

7. How does a technician discharge static buildup?

A. Touching the painted part of the computer case
B. Touching an unpainted part of the computer case
C. Touching an antistatic wrist strap before touching any computer equipment
D. Touching an antistatic mat before touching any computer equipment

8. Which device is designed specifically to protect computers and electrical devices from excess electrical voltage?

A. Power strip
B. Standby power supply
C. Surge protector
D. Uninterruptible power supply

9. Which of the following effects can be observed on computer components as a result of climate? (Choose three.)

A. Components overheat if it is too hot.
B. Moisture damages computer parts if it is too humid.
C. Components work too slowly if it is too cold.
D. The risk of ESD increases if the humidity is too low.
E. The risk of ESD increases if the temperature is too high.
F. Components overheat if the humidity is too low.

10. Which condition refers to a sudden and dramatic increase in voltage, which is usually caused by lighting?

A. Brownout
B. Sag
C. Spike
D. Surge

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CHAPTER 3

Computer Assembly Step by Step

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- How do I open the case?
- What is the process to install the power supply?
- How do I attach the components to the motherboard and install the motherboard?
- How do I install internal drives?
- How do I install drives in external bays?
- How do I install adapter cards?
- What is the process to connect all internal cables?
- How do I reattach the side panels and connect external cables to the computer?
- What happens when I boot the computer for the first time?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

electrostatic discharge *page xx*

power supply *page xx*

motherboard *page xx*

central processing unit (CPU) *page xx*

heat sink/fan *page xx*

zero insertion force (ZIF) socket *page xx*

thermal compound *page xx*

isopropyl alcohol *page xx*

random access memory (RAM) *page xx*

volatile memory *page xx*

hard disk drive (HDD) *page xx*

optical drive *page xx*

Molex power connector *page xx*

floppy disk drive (FDD) *page xx*

Berg power connector *page xx*

adapter card *page xx*

network interface card (NIC) *page xx*

video adapter card *page xx*

Advanced Technology Extended (ATX) *page xx*

serial advanced technology attachment (SATA) power connector *page xx*

parallel advanced technology attachment (PATA) cable *page xx*

serial advanced technology attachment (SATA) data cable *page xx*

Basic Input/Output System (BIOS) *page xx*

beep code *page xx*

complementary metal-oxide semiconductor (CMOS) *page xx*

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Assembling computers is a large part of a technician's job. As a technician, you will need to work in a logical, methodical manner when working with computer components. As with any learned trade, your computer assembly skills will improve dramatically with practice.

Open the Case

Computer cases are produced in a variety of form factors. Form factors refer to the size and shape of the case.

Prepare the workspace before opening the computer case. There should be adequate lighting, good ventilation, and a comfortable room temperature. The workbench or table should be accessible from all sides. Avoid cluttering the surface of the workbench or table with tools and computer components. An antistatic mat on the table will help prevent physical and ***electrostatic discharge*** (ESD) damage to equipment. Small containers can be used to hold screws and other parts as you remove them.

There are different methods of opening cases. To learn how to open a particular computer case, consult the user manual or manufacturer's website. Most computer cases are opened in one of the following ways:

- The computer case cover can be removed as one piece.
- The case's top and side panels can be removed.
- The top of the case may need to be removed before the side panels can be removed.

Install the Power Supply

A technician may be required to replace or install a ***power supply***, as shown in Figure 3-1. Most power supplies can fit only one way in the computer case. Usually, three or four screws attach the power supply to the case. Power supplies have fans that can vibrate and loosen screws that are not secured. When installing a power supply, make sure that all the screws are used and that they are properly tightened.

These are the power supply installation steps:



Step 1. Insert the power supply into the case.

Step 2. Align the holes in the power supply with the holes in the case.

Step 3. Secure the power supply to the case using the proper screws.

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Figure 3-1 Power Supply



Virtual Desktop Activity: Power Supply

Complete the power supply layer in the Virtual Desktop. Refer to the Virtual Desktop software on the CD that comes with this book.

Lab 3.2.0: Install the Power Supply

In this lab you install the power supply in the computer. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Attach the Components to the Motherboard and Install the Motherboard

This section details the steps to install components on the ***motherboard*** and then install the motherboard into the computer case.

After completing this section, you will meet these objectives:

- Install a CPU and a heat sink/fan assembly.
- Install the RAM.
- Install the motherboard.

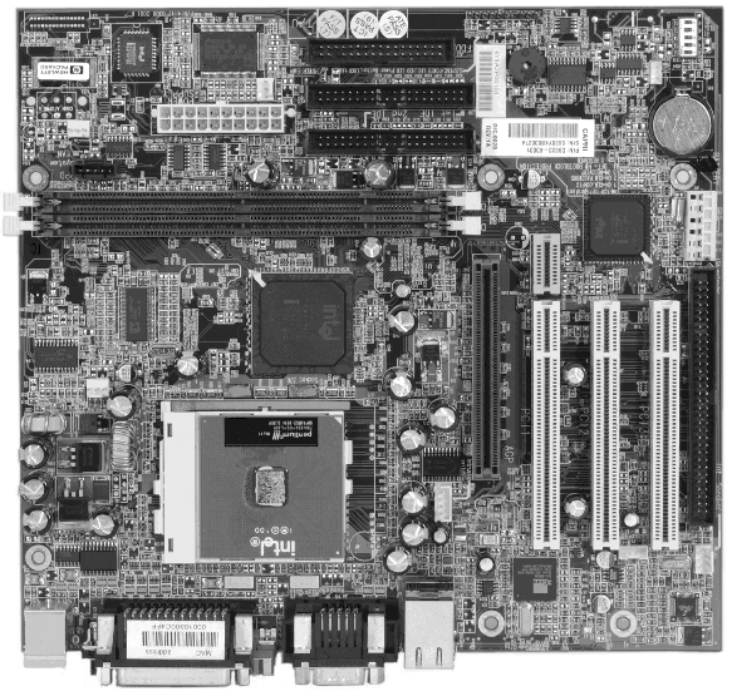
Install a CPU and a Heat Sink/Fan Assembly

The ***central processing unit (CPU)*** and the ***heat sink/fan*** assembly may be installed on the motherboard before the motherboard is placed in the computer case.

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Figure 3-2 shows a close-up view of the CPU and the motherboard. The CPU and motherboard are sensitive to electrostatic discharge. When handling a CPU and motherboard, make sure that you place them on a grounded antistatic mat. You should wear an antistatic wrist strap while working with these components.

Figure 3-2 CPU and Motherboard



Caution

When handling a CPU, do not touch the CPU contacts at any time.

The CPU is secured to the socket on the motherboard with a locking assembly. CPU sockets today are ***zero insertion force (ZIF) sockets***. You should be familiar with the locking assembly before attempting to install a CPU into the socket on the motherboard.

Thermal compound helps keep the CPU cool. Figure 3-3 shows thermal compound being applied to the CPU.

When you are installing a used CPU, clean the CPU and the base of the heat sink with ***isopropyl alcohol***. Doing this removes all traces of old thermal compound. The surfaces are now ready for a new layer of thermal compound. Follow all manufacturer recommendations about applying the thermal compound.

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Figure 3-3 Thermal Compound on the CPU

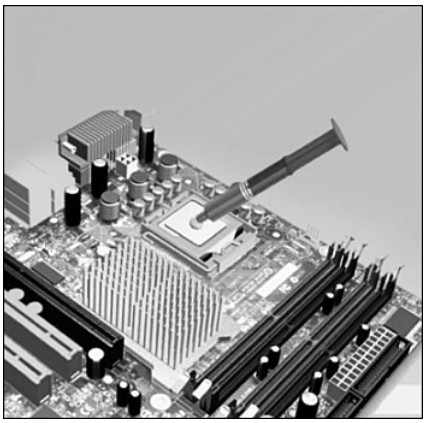
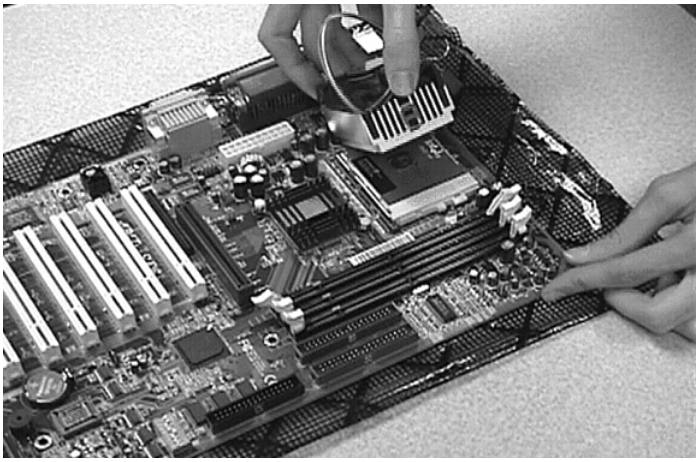


Figure 3-4 shows the heat sink/fan assembly. It is a two-part cooling device. The heat sink draws heat away from the CPU, and the fan moves the heat away from the heat sink. The heat sink/fan assembly usually has a three-pin power connector.

Figure 3-4 Heat Sink/Fan Assembly on the Motherboard



Follow these instructions for CPU and heat sink/fan assembly installation:

How To

Step 1. Align the CPU so that the Connection 1 indicator is lined up with Pin 1 on the CPU socket. Doing this ensures that the orientation notches on the CPU are aligned with the orientation keys on the CPU socket.

Step 2. Place the CPU gently into the socket.

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Step 3. Close the CPU load plate and secure it in place by closing the load lever and moving it under the load lever retention tab.

Step 4. Carefully apply a small amount of thermal compound to the CPU, and spread it evenly. Follow the application instructions provided by the manufacturer.

Step 5. Align the heat sink/fan assembly retainers with the holes on the motherboard.

Step 6. Place the heat sink/fan assembly onto the CPU socket, being careful not to pinch the CPU fan wires.

Step 7. Tighten the heat sink/fan assembly retainers to secure the assembly in place.

Step 8. Connect the heat sink/fan assembly power cable to the header on the motherboard.

Install the RAM

Like the CPU and the heat sink/fan assembly, ***random-access memory (RAM)*** is installed in the motherboard before the motherboard is secured in the computer case. Before you install a memory module, consult the motherboard documentation or website of the manufacturer to ensure that the RAM is compatible with the motherboard.

RAM provides temporary data storage for the CPU while the computer is operating. RAM is ***volatile memory***, which means that its contents are lost when the computer is shut down. Typically, more RAM enhances your computer's performance.

Follow these steps for RAM installation:



Step 1. Align the notches on the RAM module to the keys in the slot, and press down until the side tabs click into place.

Step 2. Make sure that the side tabs have locked the RAM module. Visually check for exposed contacts.

Repeat these steps for additional RAM modules.

Install the Motherboard

The motherboard is now ready to install in the computer case. Plastic and metal standoffs are used to mount the motherboard and to prevent it from touching the metal portions of the case. You should install only the standoffs that align with the holes in the motherboard. Installing any additional standoffs may prevent the motherboard from being seated properly in the computer case.

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Follow these steps for motherboard installation:



Step 1. Install standoffs in the computer case.

Step 2. Align the I/O connectors on the back of the motherboard with the openings in the back of the case.

Step 3. Align the screw holes of the motherboard with the standoffs.

Step 4. Insert all the motherboard screws.

Step 5. Tighten all the motherboard screws.



Virtual Desktop Activity: Motherboard

Complete the motherboard assembly in the Virtual Desktop motherboard layer. Refer to the Virtual Desktop software on the CD that comes with this book.



Lab 3.3.3: Install the Motherboard

In this lab you install the CPU, heat sink/fan assembly, RAM, and motherboard. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Install Internal Drives

Drives that are installed in internal bays are called internal drives. A ***hard disk drive (HDD)*** is an example of an internal drive.

Follow these steps for HDD installation:



Step 1. Position the HDD so that it aligns with the 3.5-inch drive bay.

Step 2. Insert the HDD into the drive bay so that the screw holes in the drive line up with the screw holes in the case.

Step 3. Secure the HDD to the case using the proper screws.



Virtual Desktop Activity: Internal Drives

Complete the hard drive installation in the Virtual Desktop internal drive layer. Refer to the Virtual Desktop software on the CD that comes with this book.

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Install Drives in External Bays

Drives, such as optical drives and floppy drives, are installed in drive bays that are accessed from the front of the case. Optical drives and floppy drives store data on removable media. Drives in external bays let you access the media without opening the case.

After completing this section, you will meet these objectives:

- Install the optical drive.
- Install the floppy drive.

Install the Optical Drive

An ***optical drive*** is a storage device that reads and writes information to CDs and DVDs. A ***Molex power connector*** provides the optical drive with power from the power supply. A PATA cable connects the optical drive to the motherboard.

Follow these steps for optical drive installation:

How To

Step 1. Position the optical drive so that it aligns with the 5.25-inch drive bay.

Step 2. Insert the optical drive into the drive bay so that the optical drive screw holes align with the screw holes in the case.

Step 3. Secure the optical drive to the case using the proper screws.

Install the Floppy Drive

A ***floppy disk drive (FDD)*** is a storage device that reads and writes information to a floppy disk. A ***Berg power connector*** provides the FDD with power from the power supply. A floppy data cable connects the FDD to the motherboard.

A floppy disk drive fits into the 3.5-inch bay on the front of the computer case, as shown in Figure 3-5.

Follow these steps for FDD installation:

How To

Step 1. Position the FDD so that it aligns with the 3.5-inch drive bay.

Step 2. Insert the FDD into the drive bay so that the FDD screw holes align with the screw holes in the case.

Step 3. Secure the FDD to the case using the proper screws.

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Figure 3-5 Floppy Drive Installed





Virtual Desktop Activity: Drives in External Bays

Complete the optical and floppy drive installation in the Virtual Desktop drives in the external bays layer. Refer to the Virtual Desktop software on the CD that comes with this book.



Lab 3.5.2: Install the Drives

In this lab you install the hard drive, optical drive, and floppy drive. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Install Adapter Cards

Adapter cards are installed to add functionality to a computer. Adapter cards must be compatible with the expansion slot. This section focuses on the installation of three types of adapter cards:

- PCIe x1 NIC
- PCI wireless NIC
- PCIe x16 video adapter card

After completing this section, you will meet these objectives:

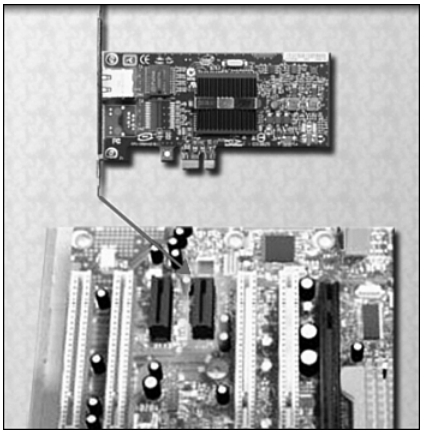
- Install the NIC.
- Install the wireless NIC.
- Install the video adapter card.

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Install the NIC

A ***network interface card (NIC)*** enables a computer to connect to a network. NICs use PCI and PCIe expansion slots on the motherboard, as shown in Figure 3-6.

Figure 3-6 NIC



Follow these steps for NIC installation:

How To

Step 1. Align the NIC to the appropriate expansion slot on the motherboard.

Step 2. Press down gently on the NIC until the card is fully seated.

Step 3. Secure the NIC PC mounting bracket to the case with the appropriate screw.

Install the Wireless NIC

A wireless NIC, as shown in Figure 3-7, enables a computer to connect to a wireless network. Wireless NICs use PCI and PCIe expansion slots on the motherboard. Some wireless NICs are installed externally with a USB connector.

Follow these steps for wireless NIC installation:

How To

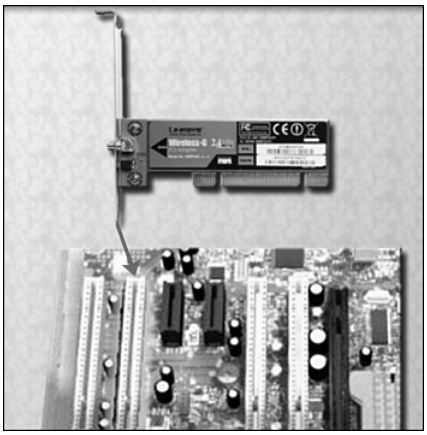
Step 1. Align the wireless NIC to the appropriate expansion slot on the motherboard.

Step 2. Press down gently on the wireless NIC until the card is fully seated.

Step 3. Secure the wireless NIC PC mounting bracket to the case with the appropriate screw.

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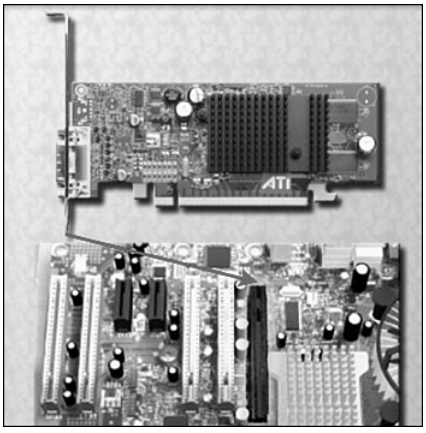
Figure 3-7 Wireless NIC



Install the Video Adapter Card

A ***video adapter card***, shown in Figure 3-8, is the interface between a computer and a display monitor. An upgraded video adapter card can provide better graphics capabilities for games and graphic programs. Video adapter cards use PCI, AGP, and PCIe expansion slots on the motherboard.

Figure 3-8 Video Adapter Card



Follow these steps for video adapter card installation:

How To

Step 1. Align the video adapter card to the appropriate expansion slot on the motherboard.

Step 2. Press down gently on the video adapter card until the card is fully seated.

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Step 3. Secure the video adapter card PC mounting bracket to the case with the appropriate screw.



Virtual Desktop Activity: Adapter Cards

Complete the NIC, wireless NIC, and video adapter card installation in the Virtual Desktop adapter card layer. Refer to the Virtual Desktop software on the CD that comes with this book.



Lab 3.6.3: Install Adapter Cards

In this lab you install the NIC, wireless NIC, and video adapter card. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Connect All Internal Cables

Power cables are used to distribute electricity from the power supply to the motherboard and other components. Data cables transmit data between the motherboard and storage devices, such as hard drives. Additional cables connect the buttons and link lights on the front of the computer case to the motherboard.

After completing this section, you will meet these objectives:

- Connect the power cables.
- Connect the data cables.

Connect the Power Cables

This section deals with the following:

- Motherboard power connections
- SATA power connectors
- Molex power connectors
- Berg power connectors

Motherboard Power Connections

Just like other components, motherboards require power to operate. The ***Advanced Technology Extended (ATX)*** main power connector has either 20 or 24 pins. The power

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supply may also have a four-pin or six-pin auxiliary (AUX) power connector that connects to the motherboard. A 20-pin connector will work in a motherboard with a 24-pin socket.

Follow these steps for motherboard power cable installation:

How To

Step 1. Align the 20-pin ATX power connector to the socket on the motherboard.

Step 2. Gently press down on the connector until the clip clicks into place.

Step 3. Align the four-pin AUX power connector to the socket on the motherboard.

Step 4. Gently press down on the connector until the clip clicks into place.

SATA Power Connectors

Serial advanced technology attachment (SATA) power connectors use a 15-pin connector. SATA power connectors are used to connect to hard disk drives, optical drives, or any devices that have a SATA power socket.

Molex Power Connectors

Hard disk drives and optical drives that do not have SATA power sockets use a Molex power connector.

Caution

Do not use a Molex connector and a SATA power connector on the same drive at the same time.

Berg Power Connectors

The four-pin Berg power connector supplies power to a floppy drive.

Follow these steps for power connector installation:

How To

Step 1. Plug the SATA power connector into the HDD.

Step 2. Plug the Molex power connector into the optical drive.

Step 3. Plug the four-pin Berg power connector into the FDD.

Step 4. Connect the three-pin fan power connector into the appropriate fan header on the motherboard according to the motherboard manual.

Step 5. Plug the additional cables from the case into the appropriate connectors according to the motherboard manual.

Connect the Data Cables

Drives connect to the motherboard using data cables. The drive being connected determines the type of data cable used. The types of data cables are PATA, SATA, and floppy drive.

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PATA Data Cables

The ***parallel advanced technologies attachment (PATA) cable*** is sometimes called a ribbon cable because it is wide and flat. The PATA cable can have either 40 or 80 conductors. A PATA cable usually has three 40-pin connectors. One connector at the end of the cable connects to the motherboard. The other two connectors connect to drives. The end of the PATA cable is keyed and can be inserted only one way.

A stripe on the data cable denotes pin 1. Plug the PATA cable into the drive with the pin 1 indicator on the cable aligned to the pin 1 indicator on the drive connector. The pin 1 indicator on the drive connector is usually closest to the power connector on the drive. Many motherboards have two PATA drive controllers, which provides support for a maximum of four PATA drives.

SATA Data Cables

The ***serial advanced technology attachment (SATA) data cable*** has a seven-pin connector. One end of the cable is connected to the motherboard. The other end is connected to any drive that has a SATA data connector.

Floppy Data Cables

The floppy drive data cable has a 34-pin connector. Like the PATA data cable, the floppy drive data cable has a stripe to denote the location of pin 1. A floppy drive data cable usually has three 34-pin connectors. One connector at the end of the cable connects to the motherboard. The other two connectors connect to drives. If multiple floppy drives are installed, the A: drive connects to the end connector after the twist in the cable. The B: drive connects to the middle connector.

Plug the floppy drive data cable into the drive with the pin 1 indicator on the cable aligned to the pin 1 indicator on the drive connector. Motherboards have one floppy drive controller, which provides support for a maximum of two floppy drives.

Note

If pin 1 on the floppy drive data cable is not aligned with pin 1 on the drive connector, the floppy drive will not function. This misalignment will not damage the drive, but the drive activity light will display continuously. To fix this problem, turn off the computer and reconnect the data cable so that pin 1 on the cable and pin 1 on the connector are aligned. Reboot the computer.

Data Cable Installation

Follow these steps for data cable installation:

How To

Step 1. Plug the motherboard end of the PATA cable into the motherboard socket.

Step 2. Plug the connector at the far end of the PATA cable into the optical drive.

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Step 3. Plug one end of the SATA cable into the motherboard socket.

Step 4. Plug the other end of the SATA cable into the HDD.

Step 5. Plug the motherboard end of the FDD cable into the motherboard socket.

Step 6. Plug the connector at the far end of the FDD cable into the floppy drive.



Virtual Desktop Activity: Internal Cables

Complete the internal cable installation in the Virtual Desktop internal cable layer. Refer to the Virtual Desktop software on the CD that comes with this book.



Lab 3.7.2: Install Internal Cables

In this lab you install internal power and data cables in the computer. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Reattach the Side Panels and Connect External Cables to the Computer

Now that all the internal components have been installed and connected to the motherboard and power supply, the side panels are reattached to the computer case. The next step is to connect the cables for all computer peripherals and the power cable.

After completing this section, you will meet these objectives:

- Reattach the side panels to the case.
- Connect external cables to the computer.

Reattach the Side Panels to the Case

Most computer cases have two panels, one on each side. Some computer cases have one three-sided cover that slides over the case frame.

As soon as the cover is in place, make sure that it is secured at all screw locations. Some computer cases use screws that are inserted with a screwdriver. Other cases have knob-type screws that can be tightened by hand.

If you are unsure how to remove or replace the computer case, refer to the documentation or the manufacturer's website for more information.

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Caution

Handle case parts with care. Some computer case covers have sharp or jagged edges.

Connect External Cables to the Computer

After the case panels have been reattached, connect the cables to the back of the computer. Here are some common external cable connections:

- Monitor
- Keyboard
- Mouse
- USB
- Ethernet
- Power

When attaching cables, ensure that they are connected to the correct locations on the computer. For example, some mouse and keyboard cables use the same type of PS/2 connector.

Caution

When attaching cables, never force a connection.

Note

Plug in the power cable after you have connected all other cables.

Follow these steps for external cable installation:

How To

Step 1. Attach the monitor cable to the video port.

Step 2. Secure the cable by tightening the screws on the connector.

Step 3. Plug the keyboard cable into the PS/2 keyboard port.

Step 4. Plug the mouse cable into the PS/2 mouse port.

Step 5. Plug the USB cable into a USB port.

Step 6. Plug the network cable into the network port.

Step 7. Connect the wireless antenna to the antenna connector.

Step 8. Plug the power cable into the power supply.

Figure 3-9 shows all the external cables plugged into the back of the computer.

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Figure 3-9 All External Cables Plugged into the Back





Virtual Desktop Activity: External Cables

Complete the external cable installation in the Virtual Desktop external cable layer. Refer to the Virtual Desktop software on the CD that comes with this book.



Lab 3.8.2: Complete the Computer Assembly

In this lab you reattach the case and connect the external cables to complete the computer assembly. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Boot the Computer for the First Time

When the computer is booted, the ***basic input/output system (BIOS)*** performs a check of all the internal components, as shown in Figure 3-10. This check is called a power-on self test (POST).

After completing this section, you will meet these objectives:

- Identify beep codes.
- Describe the BIOS setup.

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Figure 3-10 POST Screen Shot



Identify Beep Codes

POST checks to see that all the hardware in the computer is operating correctly. If a device is malfunctioning, an error or ***beep code*** alerts the technician that a problem has occurred. Typically, a single beep denotes that the computer is functioning properly. If a hardware problem exists, the computer may emit a series of beeps. Each BIOS manufacturer uses different codes to indicate hardware problems. Table 3-1 is a sample chart of beep codes. The beep codes for your computer may be different. Consult the motherboard documentation to view beep codes for your computer.

Table 3-1 Sample Beep Codes

Beep Code	Meaning	Cause
1 beep (no video)	Memory refresh failure	Bad memory
2 beeps	Memory parity error	Bad memory
3 beeps	Base 64K memory failure	Bad memory
4 beeps	Timer not operational	Bad motherboard
5 beeps	Processor error	Bad processor
6 beeps	8042 gate A20 failure	Bad CPU or motherboard
7 beeps	Processor exception	Bad processor
8 beeps	Video memory error	Bad video card or memory

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Beep Code	Meaning	Cause
9 beeps	ROM checksum error	Bad BIOS
10 beeps	CMOS checksum error	Bad motherboard
11 beeps	Cache memory bad	Bad CPU or motherboard

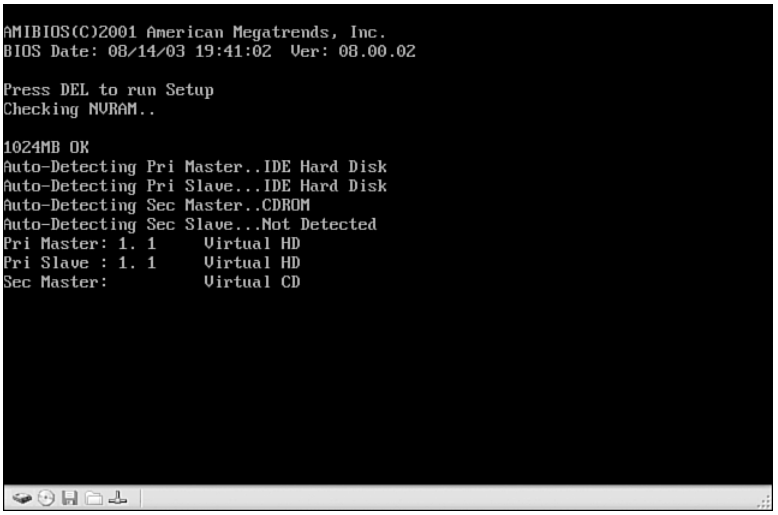
Describe the BIOS Setup

The BIOS contains a setup program used to configure settings for hardware devices. The configuration data is saved to a special memory chip called a ***complementary metal-oxide semiconductor (CMOS)***. CMOS is maintained by the battery in the computer. If this battery dies, all BIOS setup configuration data is lost. If this occurs, replace the battery and reconfigure the BIOS settings.

To enter the BIOS setup program, you must press the proper key or key sequence during POST. Most computers use the Delete key. Your computer may use another key or combination of keys, as specified during the boot process.

Figure 3-11 shows an example of a BIOS setup program.

Figure 3-11 BIOS Setup Screen Shot



Here are some common BIOS setup menu options:

- **Main:** System time, date, HDD type, and so on
- **Advanced:** Infrared port settings, parallel port settings, and so on
- **Security:** Password settings for the setup utility

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- **Others:** Low-battery alarm, system beep, and so on
- **Boot:** The computer's boot order
- **Exit:** Exits the setup utility



Lab 3.9.2: Boot the Computer

In this lab you boot the computer and verify BIOS settings. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

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Summary

This chapter detailed the steps used to assemble a computer and boot the system for the first time. These are some important points to remember:

- Computer cases come in a variety of sizes and configurations. Many of the computer's components must match the case's form factor.
- The CPU is installed on the motherboard with a heat sink/fan assembly.
- RAM is installed in RAM slots found on the motherboard.
- Adapter cards are installed in PCI and PCIe expansion slots found on the motherboard.
- Hard disk drives are installed in 3.5-inch drive bays located inside the case.
- Optical drives are installed in 5.25-inch drive bays that can be accessed from outside the case.
- Floppy drives are installed in 3.5-inch drive bays that can be accessed from outside the case.
- Power supply cables are connected to all drives and the motherboard.
- Internal data cables transfer data to all drives.
- External cables connect peripheral devices to the computer.
- Beep codes signify when hardware malfunctions.
- The BIOS setup program is used to display information about the computer components and allows the user to change system settings.

Summary of Exercises

This is a summary of the Labs, Worksheets, Remote Technician exercises, Class Discussions, **Virtual Desktop activities, and Virtual Laptop activities associated with this chapter.**



Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition.

Lab 3.2.0: Install the Power Supply

Lab 3.3.3: Install the Motherboard

Lab 3.5.2: Install the Drives

Lab 3.6.3: Install Adapter Cards

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Lab 3.7.2: Install Internal Cables

Lab 3.8.2: Complete the Computer Assembly

Lab 3.9.2: Boot the Computer



Virtual Desktop Activities

The following Virtual Desktop activities cover material from this chapter. Refer to the Virtual Desktop software on the CD that comes with this book.

Virtual Desktop Activity: Power Supply

Virtual Desktop Activity: Motherboard

Virtual Desktop Activity: Internal Drives

Virtual Desktop Activity: Drives in External Bays

Virtual Desktop Activity: Adapter Cards

Virtual Desktop Activity: Internal Cables

Virtual Desktop Activity: External Cables

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. A technician is installing a new power supply in a computer. Which type of power connector should be used to connect to a CD-ROM?

   A. Berg
   B. Mini-Molex
   C. Molex
   D. 20-pin ATX connector

2. A technician is installing a new power supply in a computer. Which type of power connector should be used to connect to an ATX motherboard?

   A. Berg
   B. Mini-Molex
   C. Molex
   D. 20-pin connector

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3. When a technician installs a new CPU, what will help maintain even contact and heat distribution between the CPU and heat sink?

   A. Silicon spray
   B. Graphite paste
   C. Glue
   D. Thermal compound

4. When installing a CPU in a ZIF socket, how should the technician align the pins to avoid damage?

   A. Pin 1 is always aligned with the corner opposite the base of the lever.
   B. Pin 1 on the CPU is aligned with Pin 1 on the ZIF socket.
   C. Pin 1 is aligned with the corner closest to the memory.
   D. The removed corner of the CPU is always aligned with the corner opposite Pin 1.

5. A technician is installing additional memory in a computer. How can the technician guarantee that the memory is correctly aligned?

   A. The label on the memory module should always face the CPU.
   B. A notch in the memory module should be aligned with a notch in the memory slot.
   C. The arrows on the memory module should be aligned with the arrows on the motherboard slot.
   D. All memory and motherboard slots are color-coded, with one red end and one blue end.

6. When mounting a motherboard in a computer case, what does the technician use to prevent the motherboard from touching the bottom of the case?

   A. Standoffs
   B. Ground-fault isolators
   C. Silicon spray
   D. Grounding straps

7. When installing adapter cards in a computer, how should a technician properly secure the card?

   A. Install the card, and attach it to the expansion slot using thermal paste.
   B. Install the card, and attach it to the motherboard using thermal pads.
   C. Install the card, and secure it using metal retaining clips located on the expansion slot.
   D. Install the card, and secure it to the case with a screw.

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8. Which two connectors are used to connect external peripherals?

A. EIDE
B. Molex
C. PATA
D. PS/2
E. USB

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CHAPTER 4

Basics of Preventive Maintenance and Troubleshooting

Objectives

Upon completion of this chapter, you will able to answer the following questions:

- What is the purpose of preventive maintenance?
- What are the elements of the troubleshooting process?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

preventive maintenance *page xx*

troubleshooting *page xx*

backup *page xx*

open-ended questions *page xx*

closed-ended questions *page xx*

Event Viewer *page xx*

Device Manager *page xx*

power-on self test (POST) *page xx*

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This chapter introduces preventive maintenance and the troubleshooting process. ***Preventive maintenance*** is a regular and systematic inspection, cleaning, and replacement of worn parts, materials, and systems. Preventive maintenance helps to prevent failure of parts, materials, and systems by ensuring that they are in good working order. ***Troubleshooting*** is a systematic approach to locating the cause of a fault in a computer system. A good preventive maintenance program helps minimize failures. With fewer failures, there is less troubleshooting to do, thus saving an organization time and money. Preventive maintenance can also include upgrading certain hardware or software such as a hard drive that is making noise, upgrading memory that is insufficient, or installing software updates for security or reliability.

Troubleshooting is a learned skill. Not all troubleshooting processes are the same, and technicians tend to refine their troubleshooting skills based on knowledge and personal experience. Use the guidelines in this chapter as a starting point to help develop your troubleshooting skills. Although each situation is different, the process described in this chapter will help you to determine your course of action when you are trying to solve a technical problem for a customer.

Explain the Purpose of Preventive Maintenance

Preventive maintenance is used to reduce the probability of hardware or software problems by systematically and periodically checking hardware and software to ensure proper operation.

Check the condition of cables, components, and peripherals. Clean components to reduce the likelihood of overheating. Repair or replace components that show signs of abuse or excess wear. Use the following tasks as a guide to create a hardware maintenance program:

- Remove dust from fan intakes.
- Remove dust from the power supply.
- Remove dust from components inside the computer.
- Clean the mouse and keyboard.
- Check and secure loose cables.

Verify that installed software is current. Follow the policies of the organization when installing security updates, operating system updates, and program updates. Many organizations do not allow updates until extensive testing has been completed. This testing is done to confirm that the update will not cause problems with the operating system and software. Use the tasks listed as a guide to create a software maintenance schedule that fits the needs of your computer equipment:

- Review security updates
- Review software updates

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- Review driver updates
- Update virus definition files
- Scan for viruses and spyware
- Remove unwanted programs
- Scan hard drives for errors
- Defragment hard drives

Be proactive in computer equipment maintenance and data protection. By performing regular maintenance routines, you can reduce potential hardware and software problems. Doing this will reduce computer downtime and repair costs.

A preventive maintenance plan is developed based on the needs of the equipment. A computer exposed to a dusty environment, such as a construction site, will need more attention than equipment in an office environment. High-traffic networks, such as a school network, can require additional scanning and removal of malicious software or unwanted files. Document the routine maintenance tasks that must be performed on the computer equipment and the frequency of each task. This list of tasks can then be used to create a maintenance program. Remember, the more you use your computer, the more frequently you should perform preventive maintenance. This can include doing a defragmentation of the hard drive weekly rather than monthly, continually scanning files for viruses rather than performing a scan once a week, and checking for updates for software and hardware every two weeks rather than monthly.

Some benefits of preventive maintenance include the following:

- Increases data protection
- Extends the life of the components
- Increases equipment stability
- Reduces repair costs
- Reduces the number of equipment failures

Identify the Steps of the Troubleshooting Process

Troubleshooting requires an organized and logical approach to problems with computers and other components. A logical approach to troubleshooting allows you to eliminate variables in a systematic order. Asking the right questions, testing the right hardware, and examining the right data help you understand the problem. This helps you form a proposed solution.

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Troubleshooting is a skill that you will refine over time. Each time you solve another problem, you will increase your troubleshooting skills by gaining more experience. You will learn how and when to combine, as well as skip, steps to reach a solution quickly. The troubleshooting process is a guideline that you can modify to fit your needs.

In the following sections, you will learn an approach to problem solving that you can apply to both hardware and software. You also can apply many of the steps to problem solving in other work-related areas.

The troubleshooting process consists of the following steps:



Step 1. Gather data from the customer.

Step 2. Verify the obvious.

Step 3. Try quick or less intensive solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

It is best to follow this process and document the process as you go through it. This will help you to identify solutions the next time you encounter a similar problem and help you work backward if you made unwanted changes.

Note

The term *customer*, as used in this course, is any user that requires technical computer assistance.

After completing the following sections, you will be able to explain the purpose of data protection and perform each step in the troubleshooting process.

Explain the Purpose of Data Protection

Before you begin troubleshooting problems, always follow the necessary precautions to protect data on a computer. Some repairs, such as replacing a hard drive or reinstalling an operating system, can put the data on the computer at risk. Make sure that you do everything possible to prevent data loss while attempting repairs.

Caution

Although data protection is not one of the six troubleshooting steps, you must protect data before beginning any work on a customer's computer. If your work results in data loss for the customer, you or your company could be held liable.

A ***backup*** is a copy of the data on a computer hard drive that is saved to media such as a CD, DVD, or tape drive. In an organization, backups are routinely done on a daily, weekly, and monthly basis.

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If you are unsure that a backup has been done, do not attempt any troubleshooting activities until you check with the customer. Here is a list of items to verify with the customer about data backups:

- Date of the last backup
- Contents of the backup
- Data integrity of the backup
- Availability of all backup media for a data restore

If the customer does not have a current backup and you are not able to create one, you should ask the customer to sign a liability release form. A liability release form should contain at least the following information:

- Permission to work on the computer without a current backup available
- Release from liability if data is lost or corrupted
- Description of the work to be performed

Gather Data from the Customer

During the troubleshooting process, gather as much information from the customer as possible. The customer will provide you with the basic facts about the problem. Here is a list of some of the important information to gather from the customer:

- Customer information
  - Company name
  - Contact name
  - Address
  - Phone number
- Computer configuration
  - Manufacturer and model
  - Operating system information
  - Network environment
  - Connection type
- Description of problem
  - Open-ended questions
  - Closed-ended questions

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When you are talking to the customer, you should follow these guidelines:

- Ask direct questions to gather information.
- Do not use industry jargon when talking to customers.
- Do not talk down to the customer.
- Do not insult the customer.
- Do not accuse the customer of causing the problem.

By communicating effectively, you will be able to elicit the most relevant information about the problem from the customer.

When gathering information from customers, use both open-ended and closed-ended questions. Start with ***open-ended questions*** to obtain general information. Open-ended questions allow customers to explain the details of the problem in their own words. Some examples of open-ended questions are

- What problems are you experiencing with your computer or network?
- What software has been installed on your computer recently?
- What were you doing when the problem was identified?
- What hardware changes have recently been made to your computer?

Based on the information from the customer, you can proceed with closed-ended questions. ***Closed-ended questions*** generally require a yes or no answer. These questions are intended to get the most relevant information in the shortest time possible. Some examples of closed-ended questions are

- Has anyone else used your computer recently?
- Can you reproduce the problem?
- Have you changed your password recently?
- Have you received any error messages on your computer?
- Are you currently logged in to the network?

The information obtained from the customer should be documented in the work order and in the repair journal. The work order is a record of what was done and the time that it took to make the repair. The repair journal is a written record of anything that was learned during the repair that can help you on future projects. Write down anything that you think might be important for you or another technician. Often, the small details can lead to the solution of a difficult problem.

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Verify the Obvious Issues

The second step in the troubleshooting process is to verify the obvious issues. Even though the customer might think that there is a major problem, start with the obvious issues before moving to more complex diagnoses.

Verify the following obvious issues:

- Loose external cable connections.
- Incorrect boot order in BIOS.
- Nonbootable disk in floppy drive.
- Power switch for an outlet is turned off.
- Surge protector is turned off.
- Device is powered off.

If you find an obvious issue that fixes the problem, you can go to the last step and close with the customer. These steps are simply a guideline to help you solve problems in an efficient manner. If the problem is not resolved when you verify the obvious issues, you will need to continue with the troubleshooting process.

Try Quick Solutions First

The next step in the troubleshooting process is to try quick solutions first. Obvious issues and quick solutions sometimes overlap each other and can be used together to repair the problem. Document each solution that you try. Information about the solutions that you have tried is vital if the problem needs to be escalated to another technician.

Some common quick solutions include

- Check that all cables are connected to the proper ports.
- Remove and reconnect cables.
- Reboot the computer or network device.
- Log in as a different user.
- Check computer for the latest OS patches and updates.

If a quick solution does not resolve the problem, document your results and try the next most likely solution. Continue this process until you have solved the problem or have tried all the quick solutions. Document the resolution for future reference.

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Gather Data from the Computer

The next step in the troubleshooting process is to gather data from the computer. You have tried all the quick solutions, but the problem is still not resolved. It is now time to verify the customer's description of the problem by gathering data from the computer.

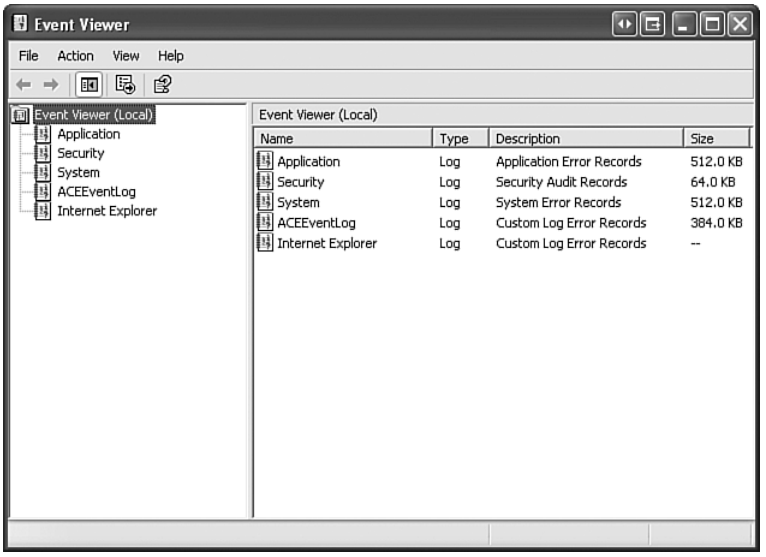
To help gather information from the computer, you will need to be aware of some of the most common utilities or features of a computer. These utilities or features include the Event Viewer, Device Manager, BIOS information and beep codes, and various diagnostic tools.

Event Viewer

When system, user, or software errors occur on a computer, the ***Event Viewer*** is updated with information about the errors. The Event Viewer application, shown in Figure 4-1, records the following information about the problem:

- The problem that occurred
- The date and time of the problem
- The severity of the problem
- The source of the problem
- Event ID number
- The user who was logged in when the problem occurred

Figure 4-1 Event Viewer



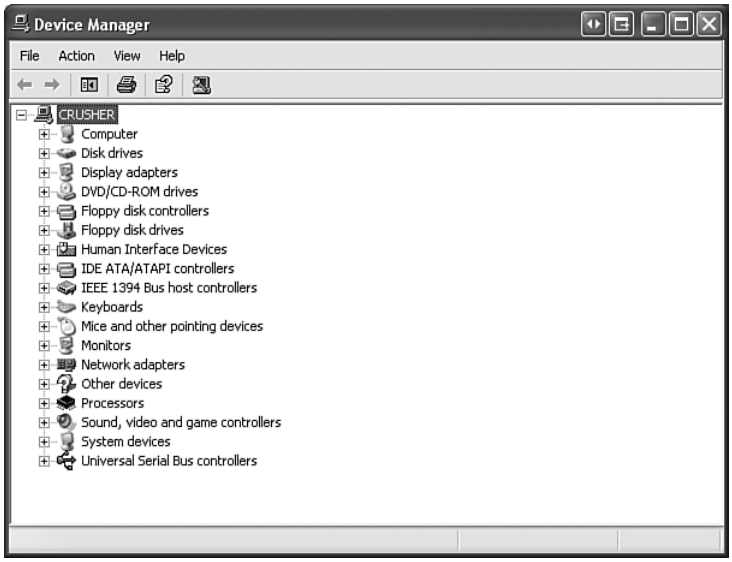
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Although this utility lists details about the error, you might still need to research the solution.

Device Manager

The ***Device Manager***, shown in Figure 4-2, displays all the devices that are configured on a computer. Any device that the operating system determines to be acting incorrectly will be flagged with an error icon. This type of error is denoted as a yellow circle with an exclamation point (!). If a device is disabled, it will be flagged with a red circle and an X.

Figure 4-2 Device Manager



Beep Codes

Each BIOS manufacturer has a unique beep sequence for hardware failures. When troubleshooting, power on the computer and then listen. As the system proceeds through the ***power-on self test (POST)***, most computers will emit one beep to indicate that the system is booting properly. If there is an error, you might hear multiple beeps. Document the beep code sequence, and research the code to determine the specific hardware failure.

BIOS Information

If the computer boots and stops after the POST, you should investigate the BIOS settings to determine where to find the problem. A device might not be detected or configured properly. Refer to the motherboard manual to make sure that the BIOS settings are accurate.

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Diagnostic Tools

Conduct research to determine what software is available to help diagnose and solve problems. There are many programs available that can help you troubleshoot hardware. Often, manufacturers of system hardware provide their own diagnostic tools. A hard drive manufacturer, for example, might provide a tool that can be used to boot the computer and diagnose problems with the hard drive when it will not start Windows.

Evaluate the Problem and Implement the Solution

The next step in the troubleshooting process is to evaluate the problem and implement the solution. When researching possible solutions for a problem, use the following sources of information:

- Your own problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

Divide larger problems into smaller problems that you can analyze and solve individually. You should prioritize solutions, starting with the easiest and fastest to implement. Create a list of possible solutions and implement them one at a time. If you implement a possible solution and it does not work, reverse the solution and try another.

Close with the Customer

After the repairs to the computer have been completed, finish the troubleshooting process by closing with the customer. Communicate the problem and the solution to the customer verbally and in all documentation. The steps to be taken when you have finished a repair and are closing with the customer include

- Discuss the solution implemented with the customer.
- Have the customer verify that the problem has been solved.
- Provide the customer with all paperwork.

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- Document the steps taken to solve the problem in the work order and in the technician's journal.
- Document any components used in the repair.
- Document the amount of time spent to resolve the problem.

Verify the solution with the customer. If the customer is available, demonstrate how the solution has corrected the computer problem. Have the customer test the solution and try to reproduce the problem. When the customer can verify that the problem has been resolved, you can complete the documentation for the repair in the work order and in your journal. The documentation should include the following information:

- The description of the problem
- The steps to resolve the problem
- The components used in the repair

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Summary

This chapter discussed the concepts of preventive maintenance and the troubleshooting process, including the following important points:

- Regular preventive maintenance reduces hardware and software problems.
- Before beginning any repair, back up the data on a computer.
- The troubleshooting process is a guideline to help you solve computer problems in an efficient manner.
- Document everything that you try, even if it fails. The documentation that you create will become a useful resource for you and other technicians.

Summary of Exercises

There are no Labs, Worksheets, Remote Technician exercises, Class Discussions, Virtual Desktop activities, or Virtual Laptop activities associated with this chapter.

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Which of the following common tasks are performed during preventive maintenance? (Choose three.)

   A. Check and secure loose cables.
   B. Update the RAM.
   C. Clean the mouse and keyboard.
   D. Update drivers.
   E. Reinstall the operating system.
   F. Install additional peripherals.

2. In which of the following situations is it recommended to ask the customer to sign a liability release form before attempting any kind of repair? (Choose two.)

   A. The technician needs to share the responsibility with the customer.
   B. The information on the computer is critical.
   C. The technician is unable to back up the customer information.
   D. The information in the backup is confidential.
   E. The customer is unable to provide a backup.

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3. What is the first step in the troubleshooting process?

A. Gather data from the computer.
B. Gather data from the customer.
C. Verify the obvious issues.
D. Evaluate the problem and implement the solution.
E. Close with the customer.
F. Try quick solutions.

4. Which type of question allows the customer to completely describe the problem?

A. Closed-ended
B. Open-ended
C. Specific
D. Technical

5. What is the last step in the troubleshooting process?

A. Gather data from the computer.
B. Gather data from the customer.
C. Verify the obvious issues.
D. Evaluate the problem and implement the solution.
E. Close with the customer.
F. Try quick solutions.

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CHAPTER 5

Fundamental Operating Systems

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- What is the purpose of an operating system?
- How do different operating systems compare with one another based on purpose, limitations, and compatibilities?
- How do you determine the appropriate operating system based on customer needs?
- How do you install an operating system?
- How do you navigate within an operating system GUI?
- What are some common preventive maintenance techniques for operating systems and how are they applied?
- What can be done to troubleshoot operating systems?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

operating system (OS) *page xx*

command-line interface (CLI) *page xx*

graphical user interface (GUI) *page xx*

real mode *page xx*

protected mode *page xx*

virtual real mode *page xx*

compatibility mode *page xx*

hardware compatibility list (HCL) *page xx*

primary partition *page xx*

active partition *page xx*

extended partition *page xx*

logical drive *page xx*

formatting *page xx*

cluster *page xx*

track *page xx*

cylinder *page xx*

drive mapping *page xx*

File Allocation Table, 32-bit (FAT32) *page xx*

New Technology File System (NTFS) *page xx*

Device Manager *page xx*

disk cloning *page xx*

NT Loader (NTLDR) *page xx*

Windows registry *page xx*

Msconfig *page xx*

Regedit *page xx*

Control Panel applets *page xx*

continues

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continued

Task Manager *page xx*

Event Viewer *page xx*

Remote Desktop *page xx*

preventive maintenance *page xx*

system utilities *page xx*

ScanDisk *page xx*

CHKDSK *page xx*

Defrag *page xx*

Automatic Updates *page xx*

Windows Restore Point *page xx*

emergency repair disk (ERD) *page xx*

Automated System Recovery (ASR) *page xx*

normal backup *page xx*

full backup *page xx*

copy backup *page xx*

incremental backup *page xx*

differential backup *page xx*

daily backups *page xx*

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The ***operating system (OS)*** controls almost all functions on a computer. In this chapter, you will learn about the components, functions, and terminology related to the Windows 2000 and Windows XP operating systems.

Explain the Purpose of an Operating System

All computers rely on an operating system (OS) to provide the interface for interaction among users, applications, and hardware. The operating system also manages the file system. Almost all modern operating systems can support more than one user, task, or CPU.

Roles of an operating system include

- Control hardware access
- Manage files and folders
- Provide user interface
- Manage applications

After completing the following sections, you will meet these objectives:

- Describe characteristics of modern operating systems
- Explain operating system concepts

Describe Characteristics of Modern Operating Systems

Regardless of the size and complexity of the computer and the operating system, all operating systems perform the same four basic functions:

- Control hardware access
- Manage files and folders
- Provide a user interface
- Manage applications

Control Hardware Access

The operating system manages the interaction between applications and the hardware. To access and communicate with the hardware, the operating system installs a device driver for each hardware component. A device driver is a small program written by the hardware manufacturer and supplied with the hardware component. When the hardware device is installed, the device driver is also installed, allowing the OS to communicate with the hardware component.

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The process of assigning system resources and installing drivers can be performed with Plug and Play (PnP). The PnP process was introduced in Windows 95 to simplify the installation of new hardware. All modern operating systems are PnP compatible. With PnP, the operating system automatically detects the PnP-compatible hardware and installs the driver for that component. The operating system then configures the device and updates the registry, which is a database that contains all the information about the computer.

Note

The registry contains information about applications, users, hardware, network settings, and file types.

File and Folder Management

The operating system creates a file structure on the hard disk drive to allow data to be stored. A file is a block of related data that is given a single name and treated as a single unit. Program and data files are grouped together in a directory. The files and directories are organized for easy retrieval and use. Directories can be kept inside other directories. These nested directories are referred to as *subdirectories*. Directories are called *folders* in Windows operating systems, and subdirectories are called *subfolders*.

The file structure on the hard drive is stored in a table called a file allocation table for Windows. This table contains the location where all the separate blocks, or clusters, that make up a file are located on the physical hard drive. The table format and cluster size for Windows vary depending on how the hard drive was formatted. The format for the file structure can be FAT, FAT32, and NTFS. These formats will be discussed later in the chapter in the section "Prepare Hard Drive."

User Interface

The operating system enables the user to interact with software and hardware. There are two types of user interfaces:

- ***Command-line interface (CLI)***: The user types commands at a prompt, as shown in Figure 5-1.
- ***Graphical user interface (GUI)***: The user interacts with menus and icons, as shown in Figure 5-2.

Most operating systems, such as Windows 2000 and Windows XP, include both a GUI and a CLI.

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Figure 5-1 Command-Line Interface



Figure 5-2 Graphical User Interface



Application Management

The operating system locates an application and loads it into the RAM of the computer. Applications are software programs, such as word processors, databases, spreadsheets, games, and many other applications. The operating system ensures that each application has adequate system resources.

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An application programming interface (API) is a set of guidelines used by programmers to ensure that the application they are developing is compatible with an operating system. Two examples of APIs are:

- **Open Graphics Library (OpenGL)**: Cross-platform standard specification for multimedia graphics
- DirectX: Collection of APIs related to multimedia tasks for Microsoft Windows

Explain Operating System Concepts

To understand the capabilities of an operating system, it is important to understand some basic terms. The following terms are often used when comparing operating systems:

- Multiuser: Two or more users can work with programs and files and share peripheral devices at the same time.
- Multitasking: The computer is capable of operating multiple applications at the same time.
- Multiprocessing: The computer can have two or more central processing units (CPU) that programs share.
- Multithreading: A program can be broken into smaller parts that can be loaded as needed by the operating system. Multithreading allows individual programs to be multitasked.

Almost all modern operating systems are multiuser and multitasking, and they support multiprocessing and multithreading.

Modes of Operation

All modern CPUs can run in different modes of operation. The mode of operation refers to the capability of the CPU and the operating environment. The mode of operation determines how the CPU will manage applications and memory. The four common modes of operation are as follows:

- Real mode
- Protected mode
- Virtual real mode
- Compatible mode

Memory allocation will determine where applications are stored in memory. Table 5-1 shows an example of the logical memory allocation.

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Table 5-1 Memory Management

Memory Type	Logical Memory Allocation
Conventional	0 to 640 KB
Upper	640 KB to 1 MB
Extended	1 MB to the maximum amount of RAM installed

The sections that follow describe these modes of operation in greater detail.

Real Mode

A CPU that operates in ***real mode*** can only execute one program at a time, and it can only address 1 MB of system memory at a time. Although all modern processors have real mode available, it is only used by DOS and DOS applications or by 16-bit operating systems, such as Windows 3.*x*. In real mode, when an application creates an error, the entire computer can be affected because the program has direct access to memory. This can cause the computer to stop responding, restart, or shut down due to corruption of the memory space. Table 5-2 is a chart of some common DOS commands that can still be used in modern operating systems, such as Windows XP.

Table 5-2 Common DOS Commands

Command	Function
HELP	Provides command-line help
DIR	Displays the contents of a directory
ATTRIB	Changes the attributes of a file to indicate a read-only, archive, system, or hidden file
EDIT	Opens a file for editing
COPY	Copies a file
XCOPY	Copies files and subdirectories
FORMAT	Formats a disk
MD	Makes a new directory
CD	Changes to a specified directory
RD	Removes a directory

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Protected Mode

A CPU that operates in ***protected mode*** has access to all the memory in the computer, including virtual memory. Virtual memory is hard disk space that is used to emulate RAM. Operating systems that use protected mode can manage multiple programs simultaneously. Protected mode provides 32-bit access to memory, drivers, and transfers between input and output (I/O) devices. Protected mode is used by 32-bit operating systems, such as Windows 2000 and Windows XP. In protected mode, applications are protected from using the memory reserved for another application that is currently running.

Virtual Real Mode

A CPU that operates in ***virtual real mode*** allows a real-mode application to run within a protected-mode operating system. This can be demonstrated when a DOS application runs in a 32-bit operating system, such as Windows XP.

Compatibility Mode

Compatibility mode creates the environment of an earlier operating system for applications that are not compatible with the current operating system. As an example, an application that checks the version of the operating system can be written for Windows NT and require a particular service pack. Compatibility mode can create the proper environment or version of the operating system to allow the application to run as if it is in the intended environment.

Describe and Compare Operating Systems to Include Purpose, Limitations, and Compatibilities

A technician can be asked to choose and install an operating system for a customer. The type of OS selected depends on the customer's requirements for the computer. There are two distinct types of operating systems:

- **Desktop operating systems**: A desktop operating system is intended for use in a small office/home office (SOHO) with a limited number of users.
- **Network operating systems**: A network operating system (NOS) is designed for a corporate environment serving multiple users with a wide range of needs.

After completing the following sections, you will meet the following objectives:

- Describe desktop operating systems
- Describe network operating systems

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Describe Desktop Operating Systems

A desktop OS has the following characteristics:

- Supports a single user
- Runs single-user applications
- Shares files and folders on a small network with limited security

In the current software market, the most commonly used desktop operating systems fall into three groups:

- **Microsoft Windows**: Windows is one of the most popular operating systems today. The following products are desktop versions of the Microsoft Windows operating systems:
  - **Windows XP Professional**: Used on most computers that will connect to a Windows server on a network
  - **Windows XP Home Edition**: Used on home computers and has very limited security
  - **Windows XP Media Center**: Used on entertainment computers for viewing movies and listening to music
  - **Windows XP Tablet PC Edition**: Used for tablet PCs
  - **Windows XP 64-bit Edition**: Used for computers with 64-bit processors
  - **Windows 2000 Professional**: Older Windows operating system that has been replaced by Windows XP Professional
  - **Windows Vista**: Newest version of Windows
- **Apple Mac OS**: Apple computers are proprietary and use an operating system called Mac OS. Mac OS is designed to be a user-friendly GUI operating system. Current versions of Mac OS are now based on a customized version of UNIX.
- **UNIX/Linux**: UNIX, which was introduced in the late 1960s, is one of the oldest operating systems. There are many different versions of UNIX today. One of the most recent is the extremely popular Linux. Linux was developed by Linus Torvalds in 1991, and it is designed as an open-source operating system. Open-source programs allow the source code to be distributed and changed by anyone as a free download or from developers at a much lower cost than other operating systems.

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Describe Network Operating Systems

A network OS has the following characteristics:

- Supports multiple users
- Runs multiuser applications
- Is robust and redundant
- Provides increased security compared to desktop operating systems

The most commonly used network operating systems are as follows:

- **Microsoft Windows**: Network operating systems offered by Microsoft are Windows 2000 Server and Windows Server 2003. Windows Server operating systems use a central database called Active Directory to manage network resources.
- **Novell NetWare**: Novell NetWare was the first OS to meet network OS requirements and enjoy widespread deployment in PC-based LANs back in the 1980s.
- **Linux**: Linux operating systems include Red Hat, Caldera, SuSE, Debian, and Slackware.
- **UNIX**: Various corporations offered proprietary operating systems based on UNIX.



Worksheet 5.2.2: NOS Certifications and Jobs

In this activity, you will use the Internet, a newspaper, or magazines to gather information about network operating system certifications and jobs that require these certifications. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can complete this worksheet now or wait to do so until the end of the chapter.

Determine Operating System Based on Customer Needs

To select the proper operating system to meet the requirements of your customer, you need to understand how the customer wants to use the computer. The operating system that you recommend should be compatible with any applications that will be used and should support all hardware that is installed in the computer. If the computer will be attached to a network, the new operating system should also be compatible with other operating systems on the network.

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After completing the following sections, you will meet the following objectives:

- Identify applications and environments that are compatible with an operating system
- Determine minimum hardware requirements and compatibility with the OS platform

Identify Applications and Environments That Are Compatible with an Operating System

An operating system should be compatible with all applications that are installed on a computer. Before recommending an OS to your customer, investigate the types of applications that your customer will be using. If the computer will be part of a network, the operating system must also be compatible with the operating systems of the other computers in the network. The network type determines what operating systems are compatible. Microsoft Windows networks can have multiple computers using different versions of Microsoft operating systems. The following questions offer guidelines that will help you determine the best operating system for your customer:

- **Does the computer have "off-the-shelf" applications or customized applications that were programmed specifically for this customer?** If the customer will be using a customized application, the programmer of that application will specify which operating system is compatible with it. Most off-the-shelf applications specify a list of compatible operating systems on the outside of the application package.
- **Are the applications programmed for a single user or multiple users?** This information will help you decide whether to recommend a desktop OS or a network OS. If the computer will be connected to a network, make sure to recommend the same OS platform that the other computers on the network use.
- **Are any data files shared with other computers, such as a laptop or home computer?** To ensure compatibility of file formats, recommend the same OS platform that the other data file–sharing computers use.

As an example, your customer might have a Windows network installed and want to add more computers to the network. In this case, you should recommend a Windows OS for the new computers. If the customer does not have any existing computer equipment, the choice of available OS platforms increases. To make an OS recommendation, you will need to review budget constraints, learn how the computer will be used, and determine what types of applications will be installed.

Determine Minimum Hardware Requirements and Compatibility with the OS Platform

Operating systems have minimum hardware requirements that must be met for the OS to install and function correctly. Table 5-3 is a chart of the minimum hardware requirements for Windows 2000, Windows XP Pro, and Windows XP Home operating systems.

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Table 5-3 Minimum Hardware Requirements

	Windows 2000	Windows XP Pro	Windows XP Home
CPU	Pentium 133 MHz	233 MHz (single- or dual-processor system) 300 MHz or higher recommended Intel Pentium/ Celeron family AMD K6/Athlon/ Duron family, or compatible	233 MHz 300 MHz or higher recommended Intel Pentium/Celeron family AMD K6/Athlon/ Duron family, or compatible
RAM	64 MB 128 MB or higher recommended	64 MB 128 MB or higher recommended	64 MB 128 MB or higher recommended
Hard Disk Drive	2 GB with 650 MB of free space 6.4 GB with 2 GB of free space recommended	1.5 GB available hard disk space More is recommended if installing over a network	1.5 GB available hard disk space More is recommended if installing over a network
Video Adapter Card	VGA resolution SVGA resolution recommended	Super VGA (800 x 600) resolution Higher resolution recommended	Super VGA (800 x 600) resolution Higher resolution recommended

Identify the equipment that your customer has in place. If hardware upgrades are necessary to meet the minimum requirements for an OS, conduct a cost analysis to determine the best course of action. In some cases, it can be less expensive for the customer to purchase a new computer than to upgrade the current system. In other cases, it can be cost effective to upgrade one or more of the following components:

- RAM
- Hard disk drive
- CPU
- Video adapter card

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Note

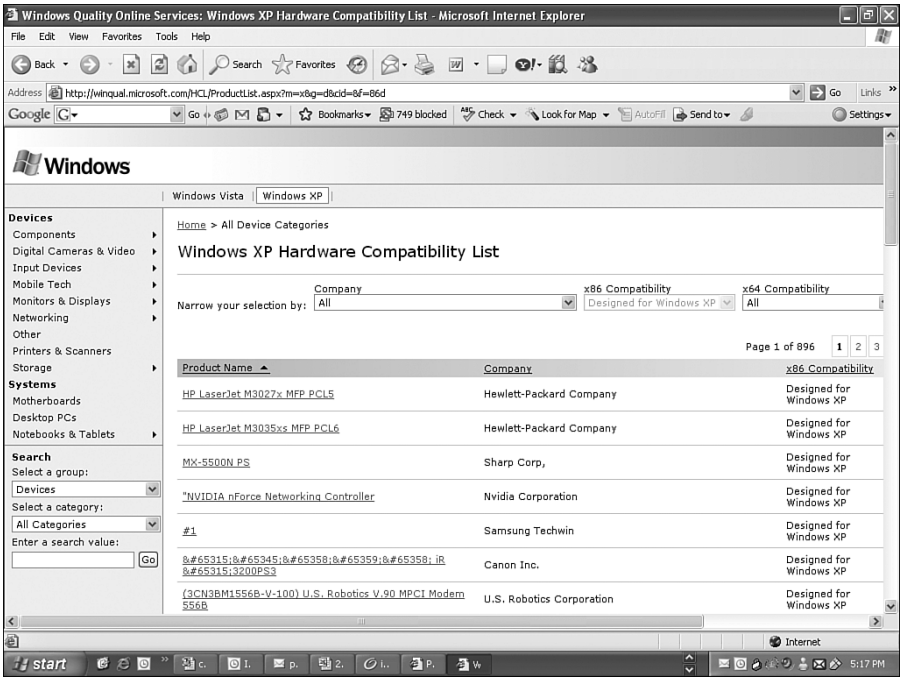
In some cases, the application requirements can exceed the hardware requirements of the operating system. For the application to function properly, it will be necessary to satisfy the additional requirements.

After you have determined the minimum hardware requirements for an OS, you should ensure that all the hardware in the computer is compatible with the operating system that you have selected for your customer.

Hardware Compatibility List

Most operating systems have a ***hardware compatibility list (HCL)*** that can be found on the manufacturer's website, as shown in Figure 5-3. These lists provide a detailed inventory of hardware that has been tested and is known to work with the operating system. If any of your customer's existing hardware is not on the list, those components might need to be upgraded to match components on the HCL.

Figure 5-3 Hardware Compatibility List



Note

An HCL might not be continuously maintained and therefore might not be a comprehensive reference.

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Worksheet 5.3.2: Upgrade Hardware Components

In this worksheet, you will use the Internet, a newspaper, or a local store to gather information about hardware components. The scenario is that your customer's computer currently has 1 module of 256-MB RAM, a 40-GB hard disk drive, and an AGP video adapter card with 32 MB of RAM. Your customer wants to be able to play advanced video games. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can complete this worksheet now or wait to do so until the end of the chapter.

Install an Operating System

As a technician, you might have to perform a clean installation of an operating system. Perform a clean install in the following situations:

- When a computer is passed from one employee to another
- When the operating system is corrupted
- When a new replacement hard drive is installed in a computer

Figure 5-4 shows an example of the Windows XP installation welcome screen.

Figure 5-4 Windows XP Installation



After completing the following sections, you will meet these objectives:

- Identify hard drive setup procedures
- Prepare the hard drive
- Install the operating system using default settings

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- Create user accounts
- Complete the installation
- Describe custom installation options
- Identify the boot sequence files and registry files
- Describe how to manipulate operating system files
- Describe directory structures

Identify Hard Drive Setup Procedures

The installation and initial booting of the operating system is called the operating system setup. Although it is possible to install an operating system over a network from a server or from a local hard drive, the most common installation method is with CDs and DVDs. To install an OS from a CD or DVD, first configure the BIOS setup to boot the system from the CD or DVD.

Partitioning and Formatting

Before installing an operating system on a hard drive, the hard drive must be partitioned and formatted. When a hard drive is partitioned, it is logically divided into one or more areas. When a hard drive is formatted, the partitions are prepared to hold files and applications. During the installation phase, most operating systems automatically partition and format the hard drive. A technician should understand the process relating to hard drive setup. The following terms are used when referring to hard drive setup:

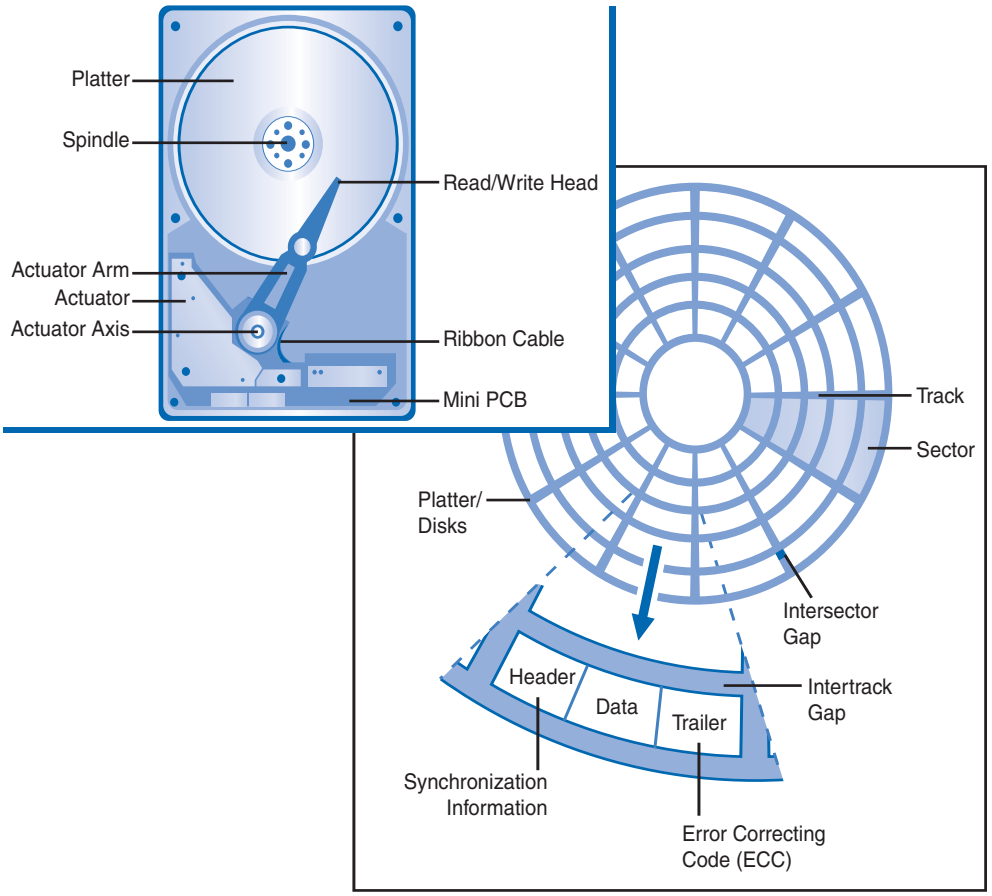
- ***Primary partition***: This partition is usually the first partition. A primary partition cannot be subdivided into smaller sections. There can be up to four partitions per hard drive.
- ***Active partition***: This partition is the partition used by the operating system to boot the computer. Only one primary partition can be marked active.
- ***Extended partition***: This partition normally uses the remaining free space on a hard drive or takes the place of a primary partition. There can be only one extended partition per hard drive, and it can be subdivided into smaller sections called logical drives.
- ***Logical drive***: This drive is a section of an extended partition that can be used to separate information for administrative purposes.
- ***Formatting***: This process prepares a file system in a partition for files to be stored.
- ***Cluster***: A cluster is also called a file allocation unit. It is the smallest unit of space used for storing data.
- ***Track***: A track is one complete circle of data on one side of a hard drive platter. A track is broken into groups of 512 bytes, called sectors.

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- ***Cylinder***: A cylinder is a stack of tracks lined up one on top of another to form a cylinder shape.
- ***Drive mapping***: Drive mapping is a letter assigned to a physical or logical drive.

Figure 5-5 shows how the different parts of a hard drive correspond.

Figure 5-5 Hard Drive Access



Prepare Hard Drive

A clean installation of an operating system proceeds as if the disk were brand new; there is no attempt to preserve any information that is currently on the hard drive. The first phase of the installation process entails partitioning and formatting the hard drive. This process prepares the disk to accept the file system. The file system provides the directory structure that organizes the user's operating system, application, configuration, and data files.

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The Windows XP operating system can use one of two file systems:

- ***File Allocation Table, 32-bit (FAT32)***: A file system that can support partition sizes up to 2 TB, or 2048 GB. The FAT32 file system is supported by Windows 95, Windows 98, Windows Me, Windows 2000, and Windows XP.
- ***New Technology File System (NTFS)***: A file system that can support partition sizes up to 16 exabytes, in theory. (An exabyte is 2^{60} bytes.) NTFS incorporates more file system security features and extended attributes than the FAT file system.

How To

Figure 5-6 through Figure 5-10 show the five steps required to partition and format a drive in Windows XP.

Figure 5-6 Hard Drive Preparation and Setup: Step 1



Figure 5-7 Hard Drive Preparation and Setup: Step 2



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Figure 5-8 Hard Drive Preparation and Setup: Step 3



Figure 5-9 Hard Drive Preparation and Setup: Step 4



Lab 5.4.2: Install Windows XP

In this lab, you will install the Windows XP Professional operating system. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

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Figure 5-10 Hard Drive Preparation and Setup: Step 5



Install the Operating System Using Default Settings

When installing Windows XP, the installation wizard gives the option to install using typical (default) settings or custom settings. Using the typical settings increases the likelihood of a successful installation. However, the user must still provide the following information during the setup:

- Standards and formats that define currency and numerals
- Text input language
- Name of the user and company
- Product key
- Computer name
- Administrator password
- Date and time settings
- Network settings
- Domain or workgroup information

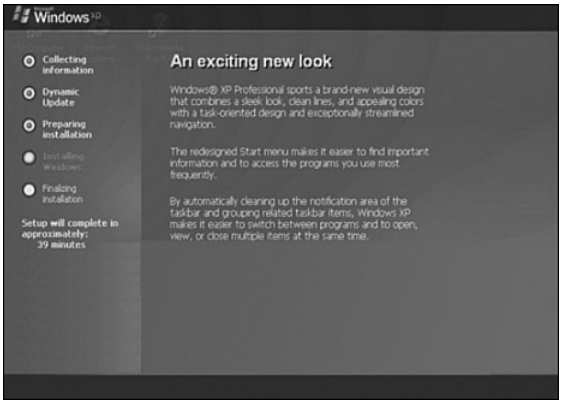
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When a computer boots up with the Windows installation CD, the Windows XP installation starts with three options:

- **Setup XP**: To run the setup and install the XP operating system, press **Enter**.
- **Repair XP**: To repair an installation, press **R** to open the Recovery Console.
- **Quit**: To quit Setup without installing Windows XP, press **F3**.

Figure 5-11 shows the installation window for Windows XP.

Figure 5-11 Installing Windows



Create Accounts

An administrator account is automatically created when Windows XP is installed. The default administrator account is named "administrator." For security purposes, change this default name as soon as possible. This privileged account should only be used to manage the computer; it should not be used as a daily account. It is recommended that you create another account with limited access for daily use. People have accidentally made drastic changes while using the administrator account instead of a limited user account. Attackers seek out the administrative account because it is so powerful.

Create a user account when prompted during the installation process. This user account will have full administrative privileges just like the administrator account. Unlike the administrator account, user accounts can be created at any time. A user account should have less permissions than the computer administrator. For example, users might have the right to read, but not modify, a file.

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Tip

Because of the security risks associated with the administrator account, it is recommended that you rename the administrator account and also disable the account after creating a new account with full administrative privileges. Because each user account is identified with a security identifier (SID), changing the name of the administrator account does not change the SID. The SID of the administrator account always begins with the letters S-1-5 and ends with -500. This would allow an attacker to figure out what account was the default administrator even if it is renamed.

Figure 5-12 shows the installation screen for setting the computer name and setting the initial administrator password.

Figure 5-12 Creating an Administrator Account



Complete the Installation

After the Windows installation copies all the necessary operating system files to the hard drive, the computer will reboot and prompt you to log in for the first time.

You must register Windows XP. As shown in Figure 5-13, you must also complete the verification that ensures that you are using a legal copy of the OS. Doing so will enable you to download patches and service packs. Performing this step requires a connection to the Internet.

Depending on the age of the media at the time of your installation, there might be updates to install. As shown in Figure 5-14, you can use the Microsoft Update Manager from the Start menu (choose **Start** > **All Programs** > **Accessories** > **System Tools** > **Windows Update**) to scan for new software and to do the following:

- Install all service packs
- Install all patches

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Figure 5-13 Activating Windows XP After Installation

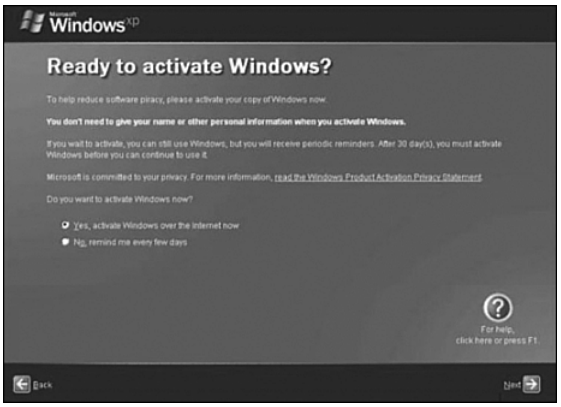
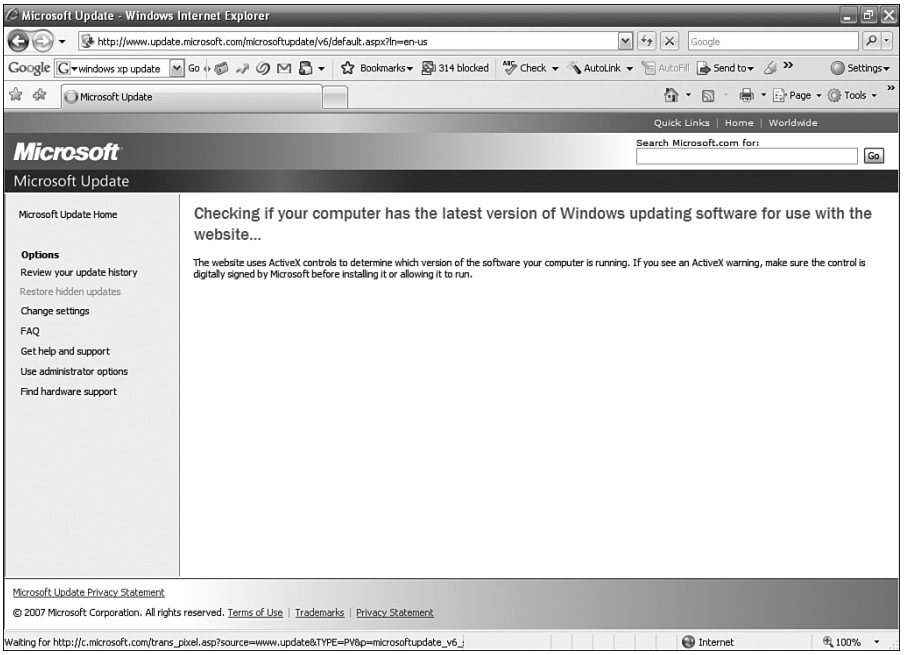


Figure 5-14 Windows Update

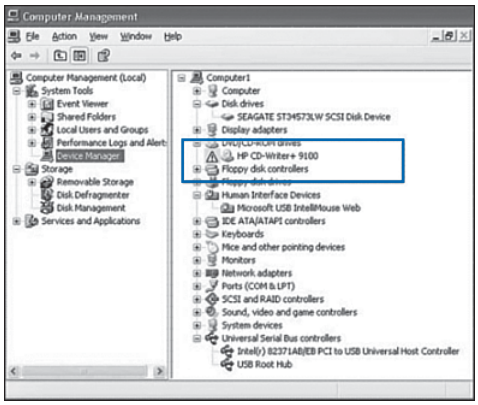


You should also verify that all hardware is installed correctly. As shown in Figure 5-15, you can use ***Device Manager*** to locate problems and to install the correct or updated drivers using the following path:

Start > **Control Panel** > **System** > **Hardware** > **Device Manager**

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Figure 5-15 Device Manager Conflicts



In Device Manager, warning icons are represented by a yellow exclamation point (!) or a red X. A yellow exclamation point represents a problem with the device. To view the problem description, right-click the device and select Properties. A red X represents a device that has been disabled. To enable the device, right-click the disabled device and select Enable. To open a category that is not yet expanded, click the plus sign (+).

Note

When Windows detects a system error, Windows reporting displays a dialog box. If you choose to send the report, Microsoft Windows error reporting (WER) collects information about the application and the module involved in the error and sends the information to Microsoft.



Lab 5.4.5: Create Accounts and Check for Updates

In this lab, you will create user accounts and configure the operating system for automatic updates after the Windows XP Professional installation process. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Describe Custom Installation Options

Installing an operating system on a single computer takes time. Imagine the time it would take to install operating systems on multiple computers, one at a time, in a large organization. To simplify this activity, you can use the Microsoft System Preparation (Sysprep) tool to install and configure the same operating system on multiple computers. Sysprep prepares an operating system that will be used on computers with different hardware configurations. With Sysprep and a disk-cloning application, technicians are able to quickly install an operating system, complete the last configuration steps for the OS setup, and install applications.

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Note

Some commonly used disk-cloning applications include Symantec PowerQuest Drive Image and Norton Ghost.

Disk cloning creates an image of a hard drive in a computer. Follow these steps for disk cloning:



Step 1. Create a master installation on one computer. This master installation includes the operating system, software applications, and configuration settings that will be used by the other computers in the organization.

Step 2. Run Sysprep. You can find the sysprep utility on the Windows XP operating system CD by opening the deploy.cab file in the \Support\Tools folder.

Step 3. Create a disk image of the configured computer using a third-party disk-cloning program.

Step 4. Copy the disk image onto a server. When the destination computer is booted, a shortened version of the Windows setup program runs. The setup will create a new system security identifier (SID), install drivers for hardware, create user accounts, and configure network settings to finish the OS install.

Identify the Boot Sequence Files and Registry Files

You should know the process that Windows XP uses when booting. Understanding these steps can help you to troubleshoot boot problems.

The boot sequence for Windows XP is as follows:

1. Power-on self test (POST) is run.
2. POST for each adapter card that has a BIOS is run.
3. BIOS reads the Master Boot Record (MBR).
4. MBR takes over control of the boot process and starts NT Loader (NTLDR).
5. NTLDR reads the boot.ini file to know which OS to load and where to find the OS on the boot partition.
6. NTLDR uses ntdetect.com to detect any installed hardware.
7. NTLDR loads the ntoskrnl.exe file and hal.dll.
8. NTLDR reads the registry files and loads device drivers.
9. The ntoskrnl.exe file starts the winlogon.exe program and displays the Windows login screen.

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Windows XP Boot Process

To begin the boot process, you first turn on the computer, which is called a cold boot. The computer performs the power-on self test (POST). Because the video adapter has not yet been initialized, any errors that occur at this point in the boot process will be reported by a series of audible tones, called beep codes.

After the POST, the BIOS locates and reads the configuration settings that are stored in the CMOS. This configuration setting is the order in which devices will be tried to see whether an operating system is located there. The BIOS boots the computer using the first drive that contains an operating system.

When the drive with the operating system is located, the BIOS locates the Master Boot Record (MBR). The MBR locates the operating system boot loader. For Windows XP, the boot loader is called ***NT Loader (NTLDR)***.

NTLDR and the Windows Boot Menu

At this point, NTLDR controls several installation steps. For example, if more than one OS is present on the disk, boot.ini gives the user a chance to select which one to use. If there are no other operating systems, or if the user does not make a selection before the timer expires, the following steps occur:

1. NTLDR runs ntdetect.com to get information about installed hardware.
2. NTLDR then uses the path specified in boot.ini to find the boot partition.
3. NTLDR loads two files that make up the core of XP: ntoskrnl.exe and hal.dll.
4. NTLDR reads the registry files, chooses a hardware profile, and loads device drivers.

Windows Registry

The ***Windows registry*** is a hierarchal database used by the Windows operating system to store information and settings for hardware, software, users, and preferences on a system. The registry is an important part of the Windows XP boot process. These registry files are recognized by their distinctive names, which begin with HKEY_, as shown in Table 5-4, followed by the name of the portion of the operating system under their control. Every setting in Windows—from the background of the desktop and the color of the screen buttons to the licensing of applications—is stored in the registry. When a user makes changes to the Control Panel settings, file associations, system policies, or installed software, the changes are stored in the registry.

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Table 5-4 Registry Keys

Key	Description
HKEY_CLASSES_ROOT	Information about which file extensions map to a particular application
HKEY_CURRENT_USER	Information, such as desktop settings and history, related to the current user of a PC
HKEY_USERS	Information about all users who have logged on to a system
HKEY_LOCAL_MACHINE	Information relating to the hardware and software
HKEY_CURRENT_CONFIG	Information relating to all active devices on a system

Each user has a unique section of the registry. The Windows login process pulls system settings from the registry to reconfigure the system to the state that it was in the last time that the user turned it on.

NT Kernel

At this point, the NT kernel, the heart of the Windows operating system, takes over. The name of this file is ntoskrnl.exe. It starts the login file called winlogon.exe and displays the XP welcome screen.

Note

If a SCSI drive will boot the computer, Windows will copy the ntbootdd.sys file during installation. This file will not be copied if SCSI drives are not being used.

Describe How to Manipulate Operating System Files

After you have installed Windows XP, you might want to make changes to the configuration. The following applications are used extensively for postinstallation modifications:

- ***Msconfig***: This boot configuration utility allows you to set the programs that will run at startup and to edit configuration files. It also offers simplified control over Windows Services, as shown in Figure 5-16. To access Msconfig, choose **Start** > **Run**, type **msconfig**, and press **Enter**.
- ***Regedit***: This application allows you to edit the registry, as shown in Figure 5-17.

Note

REGEDT32 was used with Windows NT. In Windows XP and Windows Server 2003, the REGEDT32 file is nothing more than a shortcut to the regedit.exe program. In Windows XP, you can enter regedt32.exe or regedit.exe; both commands run the same program.

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Figure 5-16 Msconfig

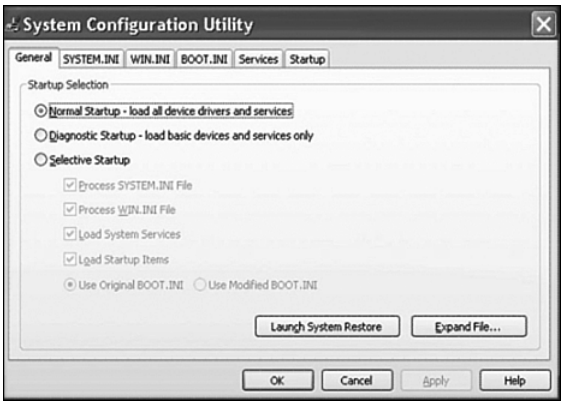
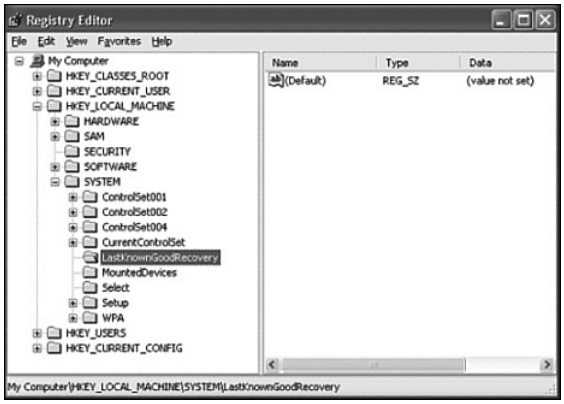


Figure 5-17 Regedit



Caution

Using regedt32.exe or regedit.exe incorrectly might cause configuration problems that could require you to reinstall the operating system.

Startup Modes

You can boot Windows in one of many different modes. Pressing **F8** during the boot process opens the Windows Advanced Startup Options menu, which allows you to select how to boot Windows. The following startup options are commonly used:

- Safe Mode: Starts Windows but only loads drivers for basic components, such as the keyboard and display.
- Safe Mode with Networking Support: Starts Windows identically to Safe Mode and also loads the drivers for network components.

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- Safe Mode with Command Prompt: Starts Windows and loads the command prompt instead of the GUI.
- Last Known Good Configuration: Enables a user to load the configuration settings of Windows that were used the last time that Windows successfully started. It does this by accessing a copy of the registry that is created for this purpose.

Note

The Last Known Good Configuration option is not useful unless it is applied immediately after a failure occurs. If the machine is restarted and, despite its difficulties, manages to open Windows, the registry key for Last Known Good Configuration will probably be updated with the faulty information.

Describe Directory Structures

In Windows, files are organized in a directory structure. The root level of the Windows partition is usually labeled drive C:\. Next, there is an initial set of standardized directories, called folders, for the operating system, applications, configuration information, and data files. Following the initial installation, users can install most applications and data in whatever directory they choose.

Files in the directory structure adhere to a Windows naming convention:

- Maximum of 255 characters can be used.
- Characters such as a period (.), a slash (/), and a backslash (\) are not allowed.
- An extension of three or four letters is added to the filename to identify the file type.
- Filenames are not case sensitive.

The following filename extensions are commonly used:

- **.doc**: Microsoft Word
- **.txt**: ASCII text only
- **.jpg**: Graphics format
- **.ppt**: Microsoft PowerPoint
- **.zip**: Compression format

The directory structure maintains a set of attributes for each file that controls how the file can be viewed or altered. The most common file attributes are as follows:

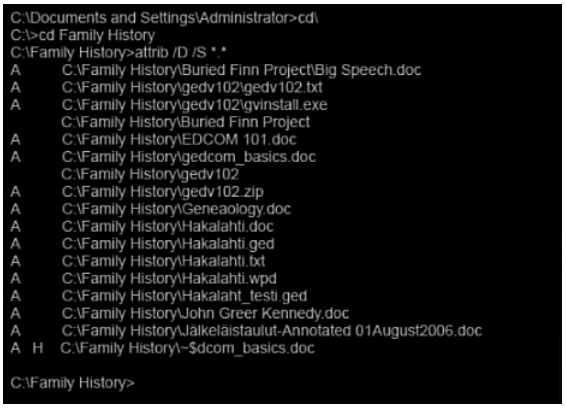
- **R**: The file is read-only.
- **A**: The file will be archived the next time that the disk is backed up.

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- **S**: The file is marked as a system file and a warning is given if an attempt is made to delete or modify the file.
- **H**: The file is hidden in the directory display.

You can view the filenames, extensions, and attributes by entering a DOS window (choose **Start** > **Run** > **cmd**) and typing the **ATTRIB** command. Navigate to the folder that contains the file that you are interested in. Type **ATTRIB** followed by the filename. Use a wildcard such as *.* to view many files at once. The attributes of each file will appear in the left column of the screen, as shown in Figure 5-18.

Figure 5-18 File Attributes



You can find information about the **ATTRIB** command at the command prompt by typing the following:

```
ATTRIB/?
```

The Windows equivalent of the **ATTRIB** command can be accessed by right-clicking a file in Windows Explorer and choosing Properties.

Note

To ensure that you can see the properties of all files in Windows Explorer, choose **Tools** > **Options** > **View** and select the **Show hidden files and folders** check box.

NTFS and FAT32 File System

Windows XP and Windows 2000 use FAT32 and NTFS file systems. Security is one of the most important differences between these file systems. NTFS can support more and larger files than FAT32 and provides more flexible security features for files and folders. Figure 5-19 shows the file permission properties of NTFS.

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Figure 5-19 NTFS Permissions



You can convert partitions from FAT32 to NTFS using the convert.exe utility. Doing this will provide the extra security advantages of NTFS. To restore an NTFS partition to a FAT32 partition, reformat the partition and restore the data from a backup.

To perform the conversion process, choose **Start** > **Run** and type **cmd**. At the command prompt, type **convert**[*driveletter*]**:/FS:NTFS**, where the *driveletter* is the drive that you want to convert from FAT or FAT32 to NTFS.

Caution

Before converting a file system, remember to back up the data.



Worksheet 5.4.9: Answer NTFS and FAT32 Questions

In this worksheet, you will answer questions about NTFS and FAT32, which are file systems used by the Windows XP operating system and provide different file system features. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can complete this worksheet now or wait to do so until the end of the chapter.

Navigate a GUI (Windows)

The operating system provides a user interface that allows you to interact with the computer. There are two methods that you can use to navigate the file system and run applications within an operating system:

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- A graphical user interface (GUI) provides graphical representations (icons) of all the files, folders, and programs on a computer, as shown in Figure 5-20. You manipulate these icons using a pointer that is controlled with a mouse or similar device. The pointer allows you to move icons by dragging and dropping, and execute programs by clicking.
- A command-line interface (CLI) is text based. You must type commands to manipulate files and execute programs.

Figure 5-20 Operating System Navigation



After completing the following sections, you will meet these objectives:

- Manipulate items on the desktop
- Explore Control Panel applets
- Explore administrative tools
- Install, navigate, and uninstall an application
- Describe upgrading operating systems

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Manipulate Items on the Desktop

After the operating system has been installed, the desktop can be customized to suit individual needs. A desktop on a computer is a graphical representation of a workspace. The desktop has icons, toolbars, and menus to manipulate files. The desktop can be customized with images, sounds, and colors to provide a more personalized look and feel.

Desktop Properties

To customize the GUI of your desktop, right-click the desktop and choose Properties, as shown in Figure 5-21. The Display Properties menu has five tabs: Themes, Desktop, Screen Saver, Appearance, and Settings. Click any of these tabs to customize your display settings.

Figure 5-21 Desktop Properties



Desktop Items

There are several items on the desktop that can be customized, such as the taskbar and Recycle Bin. To customize any item, right-click the item and then choose Properties.

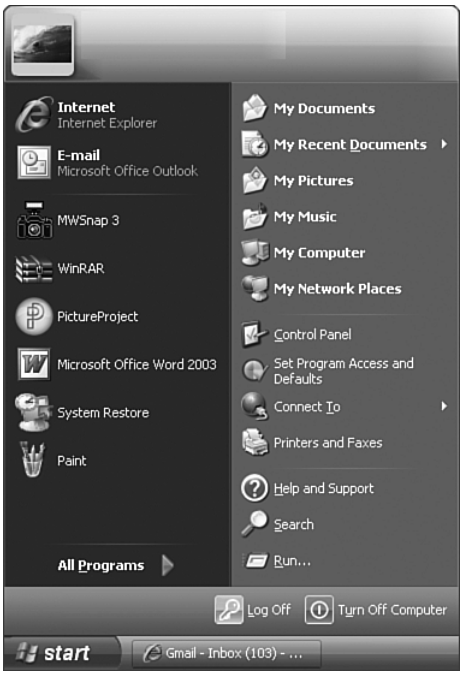
Start Menu

On the desktop, the Start menu is accessed by clicking the Start button. The Start menu, as shown in Figure 5-22, displays all the applications installed in the computer, a list of recently opened documents, and a listing of other elements, such as a search feature, help center, and system settings. The Start menu can also be customized. There are two styles of

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Start menu: XP and Classic. The XP-style Start menu will be used throughout this course for demonstrating command sequences.

Figure 5-22 Start Menu



My Computer

To access the various drives installed in the computer, double-click the My Computer icon that appears on the desktop. To customize certain settings, right-click My Computer and choose Properties. Settings that can be customized include the following:

- Computer name
- Hardware settings
- Virtual memory
- Automatic updates
- Remote access

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Launching Applications

Applications can be launched in several ways:

- Clicking the application on the Start menu
- Double-clicking the application shortcut icon on the desktop
- Double-clicking the application executable file in My Computer
- Launching the application from the Run window or command line

My Network Places

To view and configure network connections, right-click the My Network Places icon on the desktop. In My Network Places, you can connect to or disconnect from a network drive. Choose Properties to configure existing network connections, such as a wired or wireless LAN connection.

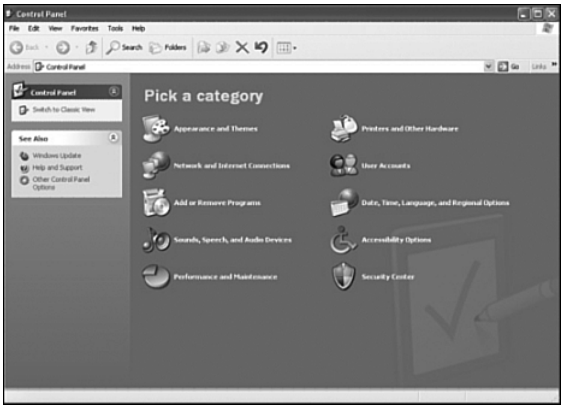
Lab 5.5.1: Run Commands

In this lab, you will open the same program by using both Windows Explorer and the **run** command. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Explore Control Panel Applets

Windows centralizes the settings for many features that control the behavior and appearance of the computer. These settings are categorized in ***Control Panel applets***, or small programs, as shown in Figure 5-23. Adding or removing programs, changing network settings, and changing the security settings are some of the configuration options available in the Control Panel.

Figure 5-23 Control Panel



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Control Panel Applets

The names of various applets in the Control Panel differ slightly depending on the version of Windows installed. In Windows XP, the icons are grouped into categories:

- **Appearance and Themes**: Applets that control the look of windows:
  - Display
  - Taskbar and Start menu
  - Folder options
- **Network and Internet Connections**: Applets that configure all the connection types:
  - Internet options
  - Network connections
- **Add or Remove Programs**: An applet to add or remove programs and windows components safely
- **Sounds, Speech, and Audio Devices**: Applets that control all the settings for sound:
  - Sounds and audio devices
  - Speech
  - Portable media devices
- **Performance and Maintenance**: Applets to find information about your computer or perform maintenance:
  - Administrative tools
  - Power options
  - Scheduled tasks
  - System
- **Printers and Other Hardware**: Applets to configure devices connected to your computer:
  - Game controllers
  - Keyboard
  - Mouse
  - Phone and modem options
  - Printers and faxes
  - Scanners and cameras

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- **User Accounts**: Applets to configure options for users and their e-mail:
  - E-mail
  - User accounts
- **Date, Time, Language, and Regional Options**: Applets to change settings based on your location and language:
  - Date and time
  - Regional and language options
- **Accessibility Options**: A wizard used to configure windows for vision, hearing, and mobility needs
- **Security Center**: Applet used to configure security settings for:
  - Internet options
  - Automatic updates
  - Windows firewall

Display Settings

You can change the display settings by using the Display Settings applet from the Control Panel or by right-clicking the desktop and selecting **Properties**. Change the appearance of the desktop by modifying the resolution and color quality, as shown in Figure 5-24.

Figure 5-24 Display Settings



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Explore Administrative Tools

The following sections cover some of the most common administrative utilities for troubleshooting, managing, and maintaining Windows XP, including

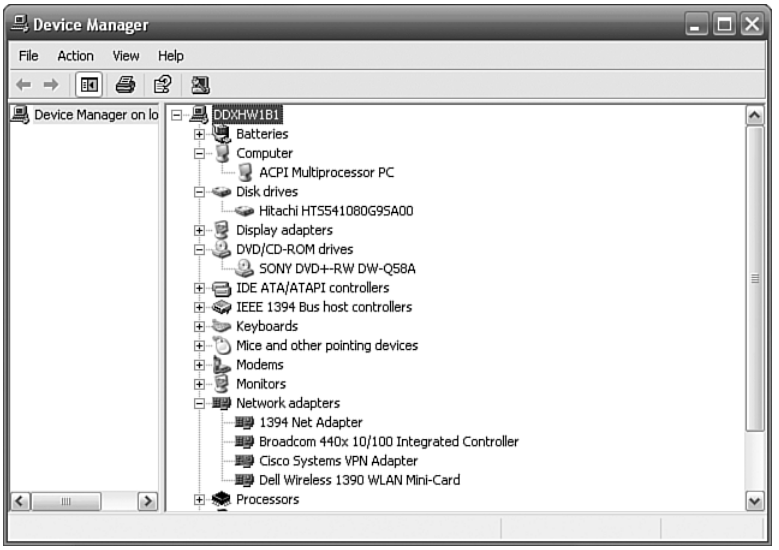
- Device Manager
- Task Manager
- Event Viewer
- Remote Desktop
- Performance Settings

Device Manager

The Device Manager, as shown in Figure 5-25, allows you to view all the settings for devices in the computer. A common task for technicians is to view the values assigned for the IRQ, I/O address, and the DMA setting for all the devices in the computer. To view the system resources in the Device Manager, use the following path:

Start > **Control Panel** > **System** > **Hardware** > **Device Manager**

Figure 5-25 Device Manager



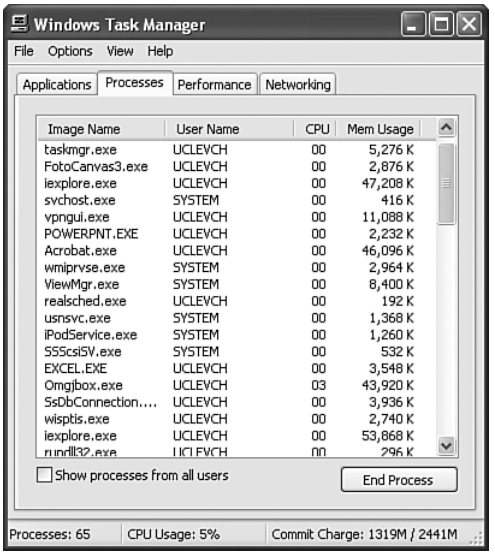
Task Manager

The ***Task Manager***, as shown in Figure 5-26, allows you to view all applications that are currently running and to close any applications that have stopped responding. The Task Manager allows you to monitor the performance of the CPU and virtual memory, view all

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processes that are currently running, and view information about the network connections. To view information in the Task Manager, press **Ctrl-Alt-Delete** and then select **Task Manager** or right-click the taskbar and select **Task Manager**.

Figure 5-26 Task Manager



Event Viewer

The ***Event Viewer***, as shown in Figure 5-27, logs a history of events regarding applications, security, and the system. These log files are a valuable troubleshooting tool. To access the Event Viewer, choose Administrative Tools > Event Viewer from the Control Panel.

Remote Desktop

The ***Remote Desktop*** allows one computer to remotely take control of another computer (as long as the computer being taken control of is powered on). To access the Remote Desktop, use the following path:

Start > All Programs > Accessories > Communications > Remote Desktop Connection

Performance Settings

To enhance the performance of the operating system, you can change some of the settings that your computer uses, such as virtual memory configuration settings, which are shown in Figure 5-28. To change the virtual memory setting, use the following path:

Start > Control Panel > System > Advanced > Performance area > Settings button > Advanced tab > Virtual memory section > Change

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Figure 5-27 Event Viewer

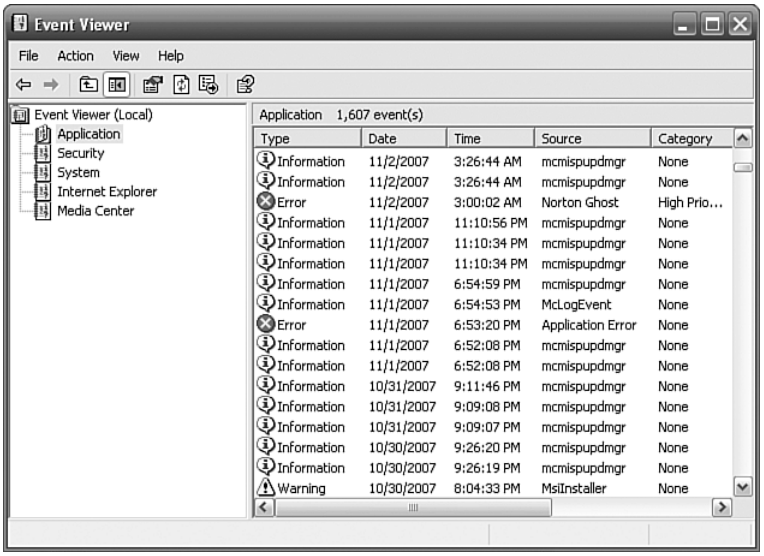
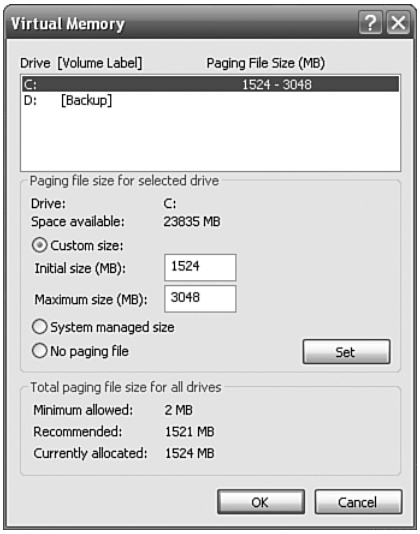


Figure 5-28 Virtual Memory



Install, Navigate, and Uninstall an Application

As a technician, you will be responsible for adding and removing software from your customers' computers. Most applications use an automatic installation process when an application CD is inserted in the optical drive. The installation process updates the Add or

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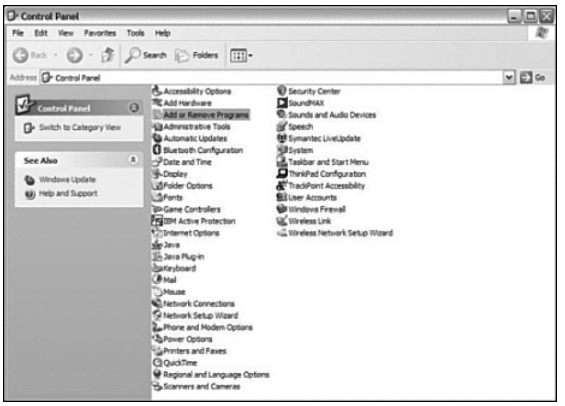
Remove Programs utility. The user is required to click through the installation wizard and provide information when requested.

Add or Remove Programs Applet

Microsoft recommends that users always use the Add or Remove Programs utility, as shown in Figure 5-29, when installing or removing applications. When you use the Add or Remove Programs utility to install an application, the utility tracks installation files so that the application can be uninstalled completely, if desired. To open the Add or Remove Programs applet, use the following path:

Start > **Control Panel** > **Add or Remove Programs**

Figure 5-29 Windows Add or Remove Programs



Add an Application

If a program or application is not automatically installed when the CD is inserted, you can use the Add or Remove Programs applet to install the application, as shown in Figure 5-30. Click the **Add New Programs** button and select the location where the application is located. Windows will install the application for you.

After the application is installed, the application can be started from the Start menu or from a shortcut icon that the application installs on the desktop. Check the application to ensure that it is functioning properly. If there are problems with the application, make the repair or uninstall the application. Some applications, such as Microsoft Office, provide a repair option in the install process. You can use this function to try to correct a program that is not working properly.

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Figure 5-30 Add an Application



Uninstall an Application

If an application is not uninstalled properly, you might be leaving files on the hard drive and unnecessary settings in the registry. Although this might not cause any problems, it depletes available hard drive space, consumes system resources, and slows the speed at which the registry is read. Figure 5-31 shows the Add or Remove Programs applet to use to uninstall programs that you no longer need. The wizard will guide you through the software removal process and remove every file that was installed.

Figure 5-31 Remove an Application



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Lab 5.5.4: Install Third-Party Software

In this lab, you will install and remove a third-party software application by using the Microsoft Windows XP Professional Installation CD. You will install the CITRIX ICA 32-bit Windows Client application. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Describe Upgrading an Operating System

Sometimes it can be necessary to upgrade an operating system. Before upgrading the operating system, check the minimum requirements of the new operating system to ensure that the computer meets the minimum specifications required. Check the HCL to ensure that the hardware is compatible with the new operating system. Back up all data before upgrading the operating system in case there is a problem with the installation.

The process of upgrading a computer system from Windows 2000 to Windows XP is quicker than performing a new installation of Windows XP. The Windows XP setup utility replaces the existing Windows 2000 files with Windows XP files during the upgrade process. However, the existing applications and settings will be saved.

Table 5-6 shows the possible upgrades for Windows 98, NT, and 2000.

Table 5-6 Operating System Upgrades

OS to Upgrade	To Windows NT	To Windows 2000	To Windows XP
Windows 98	No	Yes	Yes
Windows NT	—	Yes	Yes
Windows 2000	—	—	Yes

The steps to upgrade to the Windows XP operating system are as follows:



Step 1. Insert the Windows XP CD into the CD-ROM drive to start the upgrade process. Choose Start > Run.

Step 2. In the Run box, where D is the drive letter for the CD-ROM, type **D:\i386\winnt32** and press Enter. The Welcome to the Windows XP Setup Wizard displays.

Step 3. Choose Upgrade to Windows XP and click **Next**. The License Agreement page displays.

Step 4. Read the license agreement and click the button to accept this agreement.

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Step 5. Click **Next**. The Upgrading to the Windows XP NTFS File System page displays.

Step 6. Follow the prompts and complete the upgrade. When the install is complete, the computer will restart.

Note

The Windows XP Setup Wizard might automatically start when the CD is inserted into the optical drive.

Identify and Apply Common Preventive Maintenance Techniques for Operating Systems

Preventive maintenance for an operating system includes organizing the system, defragmenting the hard drive, keeping applications current, removing unused applications, and checking the system for errors.

After completing the following sections, you will meet these objectives:

- Create a preventive maintenance plan
- Schedule a task
- Back up the hard drive

Create a Preventive Maintenance Plan

The goal of an operating system preventive maintenance plan is to avoid problems in the future. You should perform preventive maintenance regularly, and you should also record all actions taken and observations made. Some preventive maintenance should take place when it will cause the least amount of disruption to the people who use the computers. This often means scheduling tasks at night, early in the morning, or over the weekend. There are also tools and techniques that can automate many preventive maintenance tasks.

Preventive maintenance plans should include detailed information about the maintenance of all computers and network equipment, with emphasis on equipment that could impact the organization the most. Preventive maintenance includes the following important tasks:

- Updates to the operating system and applications
- Updates to antivirus and other protective software

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- Hard drive error checking
- Hard drive backup
- Hard drive defragmentation

A preventive maintenance program that is designed to fix things before they break, and to solve small problems before they affect productivity, can provide the following benefits to users and organizations:

- Decreased downtime
- Improved performance
- Improved reliability
- Decreased repair costs

An additional part of preventive maintenance is documentation. A repair log will help you to figure out which equipment is the most or least reliable. It will also provide a history of when a computer was last fixed, how it was fixed, and what the problem was.

Schedule a Task

Some preventive maintenance consists of cleaning, inspecting, and doing minor repairs. Some preventive maintenance uses application tools that are either already in the operating system or can be loaded onto the user's hard drive. Most preventive maintenance applications can be set to run automatically according to a schedule.

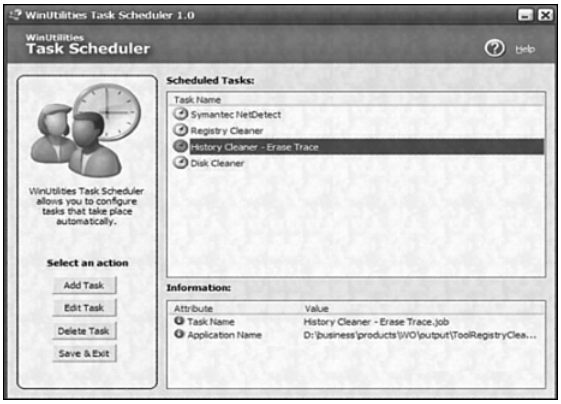
Windows has the following utilities that will launch tasks when you schedule them:

- The DOS **AT** command launches tasks at a specified time using the command-line interface. To learn more about what the **AT** command can do, access the command line (choose **Start** > **Run** > **cmd**) and type **AT /?**.
- The Windows Task Scheduler launches tasks at a specified time using a graphical user interface. To access the Windows Task Scheduler, follow this path: **Start** > **All Programs** > **Accessories** > **System Tools** > **Scheduled Tasks**.

Both of these tools allow users to set commands to run at a certain time just once, or to repeat at selected days or times. The Windows Task Scheduler, shown in Figure 5-32, is easier to learn and use than the **AT** command, especially when it comes to recurring tasks and deleting tasks already scheduled.

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Figure 5-32 Windows Task Scheduler



System Utilities

There are several utilities included with DOS and Windows that help maintain system integrity. Two ***system utilities*** that are useful tools for preventive maintenance are

- ScanDisk or CHKDSK: ***ScanDisk*** (Windows 2000) and ***CHKDSK*** (Windows XP) check the integrity of files and folders and scan the hard disk surface for physical errors. Consider using them at least once a month and also whenever a sudden loss of power causes the system to shut down.
- ***Defrag***: As files increase in size, some data is written to the next available space on the disk. In time, data becomes fragmented, or spread all over the hard drive. It takes time to seek each section of the data. Defrag gathers the noncontiguous data into one place, making files run faster.

You can access both of these utilities by using this path:

Start > **All Programs** > **Accessories** > **System Tools** > **Disk Defragmenter**

Automatic Updates

If every maintenance task had to be scheduled every time it was run, repairing computers would be much harder than it is today. Fortunately, tools such as the Scheduled Task Wizard allow many functions to be automated. But how can you automate the update of software that has not been written?

Operating systems and applications are constantly being updated for security purposes and for added functionality. It is important that Microsoft and others provide an ***Automatic Updates*** service, as shown in Figure 5-33. The update service can scan the system for needed updates and then recommend what should be downloaded and installed. The update service can download and install updates as soon as they are available, or it can download

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updates as required and install them when the computer is next rebooted. The Microsoft Update Wizard is available at this path:

Start > **Control Panel** > **System** > **Automatic Updates**

Figure 5-33 Automatic Updates



Most antivirus software contains its own update facility. It can update both its application software and its database files automatically. This feature allows it to provide immediate protection as new threats develop.

Restore Point

An update can sometimes cause serious problems. Perhaps an older program is in the system that is not compatible with the current operating system. An automatic update can install code that will work for most users but does not work with your system.

Windows System Restore, shown in Figure 5-34, is the solution for this problem. Windows XP can create an image of current computer settings, called a restore point. Then, if the computer crashes or an update causes system problems, the computer can roll back to a previous configuration.

A technician should always create a restore point before updating or replacing the operating system. To restore or create a restore point, use the following path:

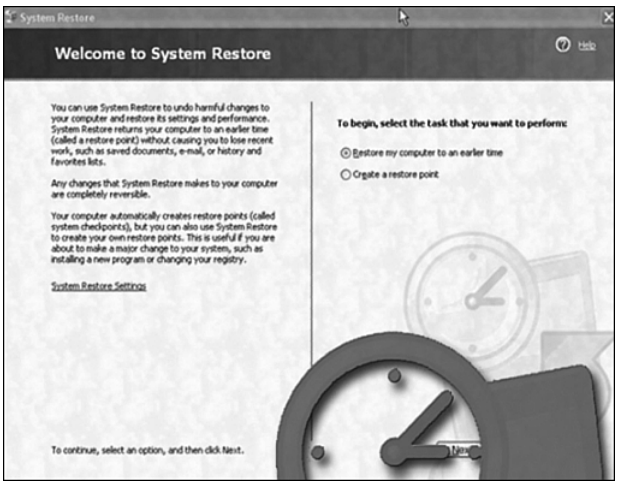
Start > **All Programs** > **Accessories** > **System Tools** > **System Restore**

Restore points should also be created at the following times:

- When an application is installed
- When a driver is installed

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Figure 5-34 Windows System Restore



Note

A restore point backs up drivers, system files, and registry settings but not application data.

ERD and ASR

Windows 2000 offers the ability to create an ***emergency repair disk (ERD)*** that saves critical boot files and configuration information necessary to troubleshoot problems in Windows. Windows XP offers the same features with the ***Automated System Recovery (ASR)*** wizard. Although both ERD and ASR are powerful troubleshooting tools, they should never replace a good backup.

A recovery CD contains the essential files used to repair the system after a serious issue, such as a hard drive crash. The recovery CD can contain the original version of Windows, hardware drivers, and application software. When the recovery CD is used, the computer will be restored to the original default configuration.

Lab 5.6.2: Restore Points

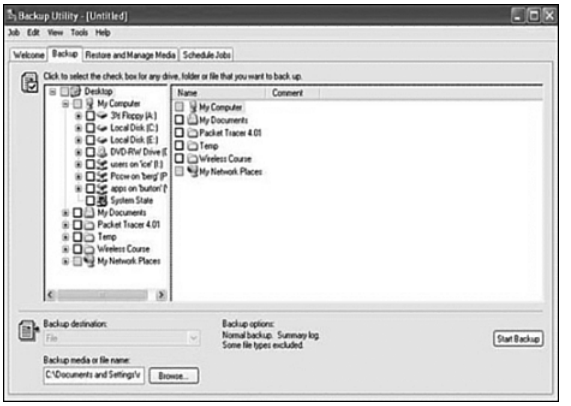
In this lab, you will create a restore point and return your computer to that point in time. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

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Back Up the Hard Drive

Just as the system restore points allow the restoration of OS configuration files, backup tools allow the recovery of data. You can use the Microsoft Backup Tool, shown in Figure 5-35, to perform backups as required. It is important to establish a backup strategy that includes data recovery. The organization's requirements will determine how often the data must be backed up and the type of backup to perform.

Figure 5-35 Microsoft Backup Utility



It can take a long time to run a backup. If the backup strategy is followed carefully, it will not be necessary to back up every file at every backup. It is only necessary to make copies of the files that have changed since the last backup. For this reason, there are several different types of backup.

Normal Backup

A ***normal backup*** is also called a ***full backup***. During a normal backup, all selected files on the disk are archived to the backup medium. These files are marked as having been archived by clearing the archive bit.

Copy Backup

A ***copy backup*** will copy all selected files. It does not mark the files as having been archived.

Incremental Backup

An ***incremental backup*** procedure backs up all the files and folders that have been created or modified since either the last normal or incremental backup. It marks the files as having been archived by clearing the archive bit. This has the effect of advancing the starting point

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of differential backups without having to rearchive the entire contents of the drive. If you have to perform a system restore, you would have to first restore the last full backup, then restore every incremental backup in order, and then restore any differential backups made since the last incremental backup.

Differential Backup

A ***differential backup*** backs up all the files and folders that have been created or modified since either the last normal backup or the last incremental backup. The differential backup does not mark the files as having been archived. Copies will be made from the same starting point until the next incremental or full backup is performed. Making differential backups is important because only the last full and differential backups are needed to restore all the data.

Daily Backup

Daily backups only back up the files that are modified on the day of the backup. Daily backups do not modify the archive bit.

To access the daily backup utility on a Windows XP Professional system, use the following path:

Start > All Programs > Accessories > System Tools > Backup

Backup Media

There are many types of backup media available for computers:

- Tape drives are devices that are used for data backup on a network server drive. Tapes drives are an inexpensive way to store a lot of data.
- The Digital Audio Tape (DAT) tape standard uses 4-mm digital audiotapes to store data in the Digital Data Storage (DSS) format.
- Digital Linear Tape (DLT) technology offers high-capacity and relatively high-speed tape backup capabilities.
- USB flash memory can hold hundreds of times the data that a floppy disk can hold. USB flash memory devices are available in many capacities and offer better transfer rates than tape devices.



Lab 5.6.3: Windows Registry Backup and Recovery

In this lab, you will back up a computer registry. You will also perform a recovery of a computer registry. The registry is also called System State data. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

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Troubleshoot Operating Systems

Most operating systems contain utilities to assist in the troubleshooting process. These utilities help technicians determine why the computer crashes or does not boot properly. The utilities also help identify the problem and indicate how to resolve it.

Follow the steps outlined in this section to accurately identify, repair, and document the problem. Take a moment to review the troubleshooting process:



Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

After completing the following sections, you will meet these objectives:

- Review the troubleshooting process
- Identify common problems and solutions

Review the Troubleshooting Process

Operating system problems can result from a combination of hardware, application, and configuration issues. Computer technicians must be able to analyze the problem and determine the cause of the error to repair the operating system. This process is called troubleshooting.

Step 1: Gathering Data from the Customer

The first step in the troubleshooting process is to gather data from the customer. This can be done by asking the customer some open-ended and closed-ended questions. Table 5-7 provides a list open-ended and closed-ended questions to ask the customer about operating system problems. (This list is *not* comprehensive.)

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Table 5-7 Operating System Problems: Open-Ended and Close-Ended Questions to Ask

Open-Ended Questions	Closed-Ended Questions
What problems are you experiencing with your computer or network?	Has anyone else used your computer recently?
What software has been installed on your computer recently?	Does the computer boot up successfully?
What were you doing when the problem was identified?	Have you changed your password recently?
What operating system do you have installed on your computer?	Have you received any error messages on your computer?
What updates or patches have been installed on your computer?	Are you currently logged in to the network?

Step 2: Verify the Obvious Issues

After you have talked to the customer, you should verify the obvious issues. Some issues for operating systems include

- Incorrect settings are in the BIOS.
- Caps Lock key is set to ON.
- Nonbootable media is in the floppy drive during computer bootup.
- Password has changed.
- Monitor does not have power.
- Monitor settings are incorrect.

Step 3: Try Quick Solutions First

After the obvious issues have been verified, try some quick solutions. A list of possible quick solutions for operating systems include

- Press **F8** during bootup to use the last known good configuration settings.
- Press **F8** to enter Safe Mode to troubleshoot video problems.
- Uninstall an application that was recently added by using the Add or Remove Programs utility in the Control Panel.
- Roll back the system using a system restore point.
- Examine the Device Manager for device conflicts.

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- Run Cleanmgr to remove temporary files.
- Run ScanDisk to repair problems with the hard drive.
- Run Defrag to speed up the hard drive.
- Reboot the computer.
- Log in as a different user.

Step 4: Gather Data from the Computer

If quick solutions did not correct the problem, it is time to gather data from the computer. Some different ways to gather information about the problem from the computer include

- System files
- Event logs
- Device Manager
- Configuration files
- Diagnostic software

Step 5: Evaluate the Problem and Implement the Solution

At this point, you will have enough information to evaluate the problem and to research and implement possible solutions. Resources for possible solutions include

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

Step 6: Close with the Customer

After you have solved the problem, you will close with the customer. A list of the steps required to complete this task include the following:

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How To

Step 1. Discuss the solution implemented with the customer.

Step 2. Have the customer verify that the problem has been solved.

Step 3. Provide the customer with all paperwork.

Step 4. Document the steps taken to solve the problem in the work order and the technician's journal.

Step 5. Document any components used in the repair.

Step 6. Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Operating system problems can be attributed to hardware, application, or configuration issues, or to some combination of the three. You will resolve some types of operating system problems more often than others. Table 5-8 is a chart of common operating system problems and solutions.

Table 5-8 Common Problems and Solutions

Problem Symptom	Possible Solution
The computer displays the desktop in 16-color VGA mode after updating the video drivers.	Use the Roll Back Driver option to remove the new video driver. Remove any unnecessary programs from the Startup tab and reboot the computer.
The computer will no longer boot to Windows and gives the "Invalid system disk" error.	Remove any floppies and CD-ROMs from the computer and verify that the HDD is set as a bootable device in the BIOS setup.
The computer will not finish loading Windows.	Boot the computer in Safe Mode and uninstall any recently installed applications.

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Summary

This chapter introduced computer operating systems. As a technician, you should be skilled at installing, configuring, and troubleshooting an operating system. The following concepts from this chapter are important to remember:

- There are several different operating systems available, and you must consider the customer's needs and environment when choosing an operating system.
- The main steps in setting up a customer's computer include preparing the hard drive, installing an operating system, creating user accounts, and configuring installation options.
- A GUI shows icons of all files, folders, and applications on the computer. A pointing device, such as a mouse, is used to navigate a GUI desktop.
- You should establish a backup strategy that allows the recovery of data. Normal, copy, differential, incremental, and daily backups are all optional backup tools available in Windows operating systems.
- Preventive maintenance techniques help to ensure optimal operation of the operating system.
- Some of the tools available for troubleshooting an operating system problem include the Windows Advanced Options menu, event logs, Device Manager, and system files.

Summary of Exercises

This is a summary of the labs and worksheets associated with this chapter.



Labs

The following Labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6):

Lab 5.4.2: Install Windows XP

Lab 5.4.5: Create Accounts and Check for Updates

Lab 5.5.1: Run Commands

Lab 5.5.4: Install Third-Party Software

Lab 5.6.2: Restore Points

Lab 5.6.3: Windows Registry Backup and Recovery

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Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6):

Worksheet 5.2.2: NOS Certifications and Jobs

Worksheet 5.3.2: Upgrade Hardware Components

Worksheet 5.4.9: Answer NTFS and FAT32 Questions

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Which open-source operating system is available on multiple hardware platforms?
   a. Linux
   b. Mac OS X
   c. Windows 2000
   d. Windows XP
2. Which registry file contains information about the hardware and software in the computer system?
   a. HKEY_CLASSES_ROOT
   b. HKEY_CURRENT_USER
   c. HKEY_LOCAL_MACHINE
   d. HKEY_USERS
3. How can the command line be accessed in Windows XP?
   a. **Start** > **Run** > **Prompt**
   b. **Start** > **Run** > **cmd**
   c. **Start** > **Control Panel** > **Prompt**
   d. **Start** > **All programs** > **Accessories** > **Terminal**
   e. **Start** > **Run** > **Terminal**

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4. Which file system is recommended for Windows XP for large file support and enhanced security?

   a. DirectX
   b. DOS
   c. FAT32
   d. HPFS
   e. NTFS

5. What is the purpose of the Microsoft Hardware Compatibility List?

   a. It lists all the hardware that runs Microsoft Office software.
   b. It lists the Microsoft software that runs on the listed hardware.
   c. It lists hardware that is supported by a Microsoft operating system.
   d. It lists hardware that works together.

6. What should be done before upgrading from Windows 2000 to Windows XP?

   a. Back up all the data files.
   b. Update all the device drivers.
   c. Detach all the peripheral devices.
   d. Download a legitimate XP authentication key.

7. Which key or key sequence will enable a user to start Windows XP in Safe Mode?

   a. Alt+B
   b. Alt+X
   c. Alt+Z
   d. F1
   e. F8
   f. The Windows key

8. What is a good example of an open-ended question that a technician can ask the user to learn more about conditions before the failure?

   a. What software has been installed recently on the computer?
   b. Does the computer boot into the operating system?
   c. Are there any beeps when the computer boots?
   d. Has anybody else used the computer recently?
   e. How many users were logged on to the network when the failure occurred?

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9. What is a common cause of the error message “Invalid system disk”?

   a. The **Delete** key was pressed during the system boot.
   b. There is a nonbootable floppy disk or CD in the drive.
   c. There is no floppy disk or CD in the drive.
   d. The BIOS has been changed to boot from the hard drive first.

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CHAPTER 6

Fundamental Laptops and Portable Devices

Objectives

Upon completion of this chapter, you will able to ans***wer the followi***ng questions:

- What are laptops and other portable devices?
- What are the components of a laptop?
- How would you compare and contrast laptop and desktop components?
- What are different ways to configure laptops?
- What are the different mobile phone standards?
- What are some common preventive maintenance techniques used for laptops and portable devices?
- What are some ways to troubleshoot laptops and portable devices?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

personal digital assistant (PDA) *page xx*

smartphone *page xx*

battery *page xx*

stylus *page xx*

audio *page xx*

battery bay *page xx*

AC power connector *page xx*

parallel port *page xx*

security keyhole *page xx*

USB *page xx*

S-video connector *page xx*

modem *page xx*

Ethernet *page xx*

network LEDs *page xx*

stereo headphone jack *page xx*

microphone jack *page xx*

ventilation *page xx*

PC combo expansion slot *page xx*

infrared port *page xx*

speakers *page xx*

laptop latch *page xx*

optical drive *page xx*

optical drive status indicator *page xx*

drive bay status indicator *page xx*

Video Graphics Array (VGA) port *page xx*

hard drive access panel *page xx*

battery latch *page xx*

docking station connector *page xx*

continues

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continued

RAM access panel *page xx*

input device *page xx*

volume control *page xx*

power button *page xx*

keyboard *page xx*

pointer controller *page xx*

fingerprint reader *page xx*

touchpad mouse *page xx*

wireless LED *page xx*

Bluetooth LED *page xx*

Num Lock LED *page xx*

Caps Lock LED *page xx*

hard drive activity LED *page xx*

power on LED *page xx*

battery status LED *page xx*

hibernate/standby LED *page xx*

function key *page xx*

base station *page xx*

docking station *page xx*

port replicator *page xx*

eject button *page xx*

laptop connector *page xx*

exhaust vent *page xx*

PC Card/ExpressCard slot *page xx*

Digital Visual Interface (DVI) port *page xx*

Line In connector *page xx*

headphone connector *page xx*

USB port *page xx*

mouse port *page xx*

keyboard port *page xx*

external diskette drive connector *page xx*

serial port *page xx*

modem port *page xx*

Ethernet port *page xx*

key lock *page xx*

form factor *page xx*

CPU throttling *page xx*

power management *page xx*

Advanced Power Management (APM) *page xx*

Advanced Configuration and Power Interface (ACPI) *page xx*

power options *page xx*

standby *page xx*

hibernate *page xx*

low battery alarm *page xx*

critical battery alarm *page xx*

hot-swappable *page xx*

Small Outline Dual In-line Memory Module (SODIMM) *page xx*

analog *page xx*

digital signals *page xx*

Short Message Service (SMS) *page xx*

Multimedia Message Service *page xx*

packet switching *page xx*

optimal operating environment *page xx*

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One of the original laptops was the GRiD Compass 1101. Astronauts used it during space missions in the early 1980s. It weighed 11 lb. (5 kg) and cost $8,000–$10,000! Laptops today often weigh less than one-half the weight and cost less than one-third the price of the GRiD Compass 1101. The compact design, convenience, and evolving technology of laptops have made them as popular as desktops.

Laptops, ***personal digital assistants (PDA)***, and ***smartphones*** are becoming more popular as their prices decrease and technology continues to progress. As a computer technician, you need to have knowledge of portable devices of all kinds. This chapter focuses on the differences between laptops and desktops and describes the features of PDAs and smartphones.

Describe Laptops and Other Portable Devices

Early laptops were heavy and expensive. Today, laptops are very popular because advances in technology have resulted in laptops that cost less, weigh less, and have improved capabilities. Many laptops can be configured with an additional video port, a FireWire port, an infrared port, or an integrated camera.

Note

Notebooks, laptops, and tablets are types of portable computers. For clarity and consistency in IT Essentials I, all portable computers will be called *laptops*.

PDAs and smartphones are examples of portable, handheld devices that are becoming more popular. PDAs offer features such as games, web surfing, e-mail, instant messaging, and many other features offered by PCs. Smartphones are cell phones with many built-in PDA capabilities. PDAs and smartphones can run some of the same software as laptops.

After completing the following sections, you will meet these objectives:

- Identify some common uses of laptops
- Identify some common uses of PDAs and smartphones

Identify Common Uses of Laptops

The most significant feature of a laptop is the compact size. The design of the laptop places the keyboard, screen, and internal components into a small, portable case.

Another popular feature of the laptop is that it can be used almost anywhere. A rechargeable ***battery*** allows the laptop to function when it is disconnected from an AC power source.

The first laptops were used primarily by businesspeople who needed to access and enter data when they were away from the office. The use of laptops was limited because of expense, weight, and limited capabilities compared to less expensive desktops.

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Today laptops have lower prices and increased capabilities. A laptop is now a real alternative to a desktop computer.

Common uses for the laptop include the following:

- Taking notes in school or researching papers
- Presenting information in business meetings
- Accessing data away from home or the office
- Playing games or watching movies while traveling
- Accessing the Internet in a public place
- Sending and receiving e-mail in a public place

Identify Common Uses of PDAs and Smartphones

The concept of the PDA has existed since the 1970s. The earliest models were computerized personal organizers designed to have a touch screen and a ***stylus***. Today, some models have both a touch screen and a keyboard and use an operating system that is similar to operating systems used on desktop computers.

The PDA is an electronic personal organizer with the following tools:

- Address book
- Calculator
- Alarm clock
- Internet access
- E-mail
- Global positioning

The smartphone is a mobile phone with PDA capabilities. Smartphones combine cell phone and computer functions in a single, handheld device. The technology of the PDA and the technology of the smartphone continue to merge.

Smartphones can include these additional options:

- Built-in camera
- Document access
- E-mail
- Abbreviated note taking
- Television

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Smartphone connectivity and PDA connectivity include Bluetooth and regular Universal Serial Bus (USB) cable connections.



Worksheet 6.1.2: Research Laptops, Smartphones, and PDAs

Research laptop, smartphone, and PDA specifications. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this worksheet now or wait until the end of the chapter.

Identify and Describe the Components of a Laptop

Common laptop features include the following:

- They are small and portable.
- They have an integrated display screen in the lid.
- They have an integrated keyboard in the base.
- They run on AC power or a rechargeable battery.
- They support hot-swappable drives and peripherals.
- Most laptops can use docking stations and port replicators to connect peripherals.

In the following sections, you look closely at the components of a laptop. You also examine a docking station. Remember, laptops and docking stations come in many models. Components can be located in different places on different models.

After completing these sections, you will meet these objectives:

- Describe the components found on the outside of the laptop
- Describe the components found on the inside of the laptop
- Describe the components found on the laptop docking station

Describe the Components Found on the Outside of the Laptop

Laptop and desktop computers use the same types of ports so that peripherals can be interchangeable. These ports are specifically designed for connecting peripherals and providing network connectivity and ***audio*** access.

Ports, connections, and drives are located on the front, back, and sides of the laptop because of the compact design. Laptops contain PC Card or ExpressCard slots to add functionality

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such as more memory, a modem, or a network connection. You learn more about PC Card and ExpressCard slots in the section "Compare and Contrast Laptop and Desktop Expansion Capabilities," later in this chapter.

Laptops require a port for external power. Laptops can operate using either a battery or an AC power adapter. This port can be used to power the computer or to charge the battery.

The exterior of the laptop also has status indicators (also called light-emitting diode [LED] displays), ports, slots, connectors, bays, jacks, vents, and a keyhole.

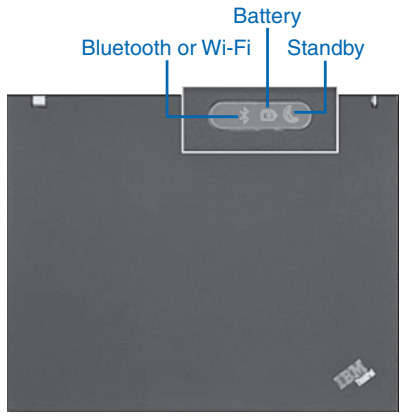
Note

Exterior components and LED displays vary among different laptops. Technicians should consult the laptop manual for a list of specific components and status displays.

The top of the typical laptop has the following three LEDs, as shown in Figure 6-1:

- Bluetooth or Wi-Fi
- Battery
- Standby

Figure 6-1 Laptop: Top View

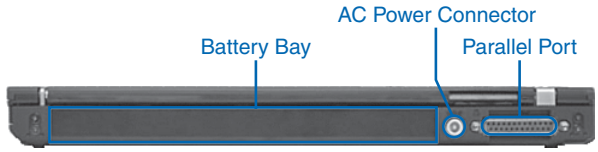


The back of some laptops has the following three components, as shown in Figure 6-2:

- ***Battery bay***
- ***AC power connector***
- ***Parallel port***

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Figure 6-2 Laptop: Rear View



A laptop operates using a battery or an AC power adapter. Laptop batteries are manufactured in various shapes and sizes. They use different types of chemicals and metals to store power.

Table 6-1 compares rechargeable batteries typically used in laptops.

Table 6-1 Laptop Battery Comparison

Type of Battery	Characteristics	Common Use	Disposal
Lithium-ion (Li-ion)	Lightweight for power, no memory effect, can easily overheat and sometimes explode. Keep cool, charge often, seek freshest batteries (most recently manufactured).	Cell phones, laptops	Check local rules, contents flammable
Lithium-polymer (Li-Poly or LiPo)	Costly, small, lightweight for power, moderate capacity, fast recharge, moderate life span, do not short-circuit, can explode but are not flammable.	PDAs, laptop computers, portable MP3 players, portable gaming devices, radio controlled airplanes	Check local rules

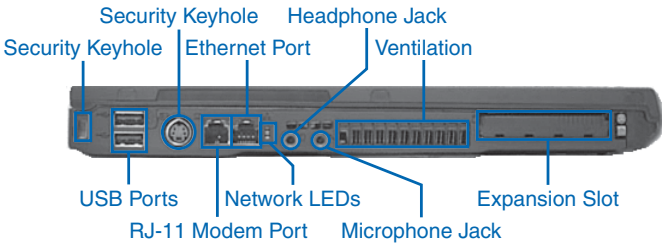
The left side of the laptop, shown in Figure 6-3, has the following ten components:

- ***Security keyhole***
- ***USB*** port
- ***S-video connector***
- ***Modem***
- ***Ethernet*** port
- ***Network LEDs***

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- ***Stereo headphone jack***
- ***Microphone jack***
- ***Ventilation***
- ***PC combo expansion slot***

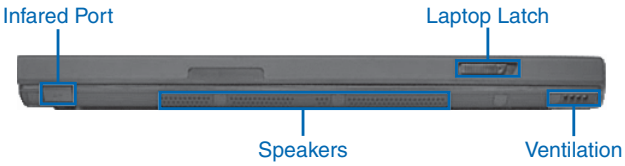
Figure 6-3 Laptop: Left-Side View



The front of the laptop, shown in Figure 6-4, has the following components:

- ***Infrared port***
- ***Speakers***
- ***Laptop latch***
- Ventilation

Figure 6-4 Laptop: Front View

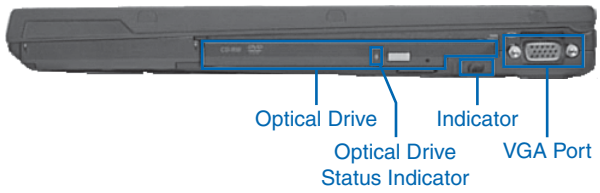


The right side of the laptop, shown in Figure 6-5, contains four components:

- ***Optical drive***
- ***Optical drive status indicator***
- ***Drive bay status indicator***
- ***Video Graphics Array (VGA) port***

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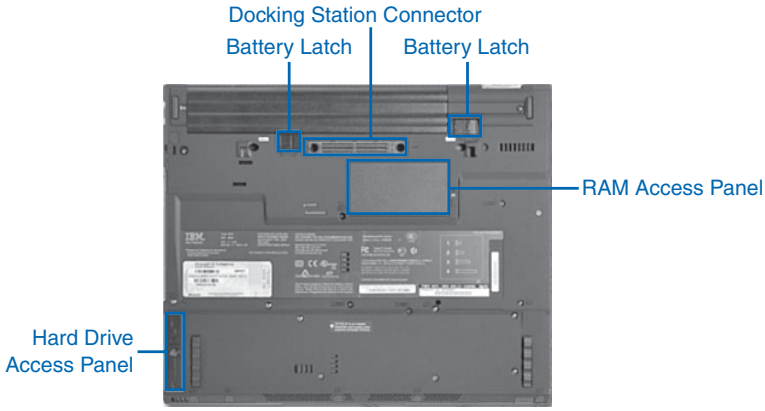
Figure 6-5 Laptop: Right-Side View



The bottom of the laptop, shown in Figure 6-6, has the following components:

- ***Hard drive access panel***
- ***Battery latches***
- ***Docking station connector***
- ***RAM access panel***

Figure 6-6 Laptop: Bottom View





Virtual Laptop Activity: Explore Laptop

Explore the different views of the Virtual Laptop. Refer to the Virtual Laptop software on the CD that accompanies this book.

Describe the Components Found on the Inside of the Laptop

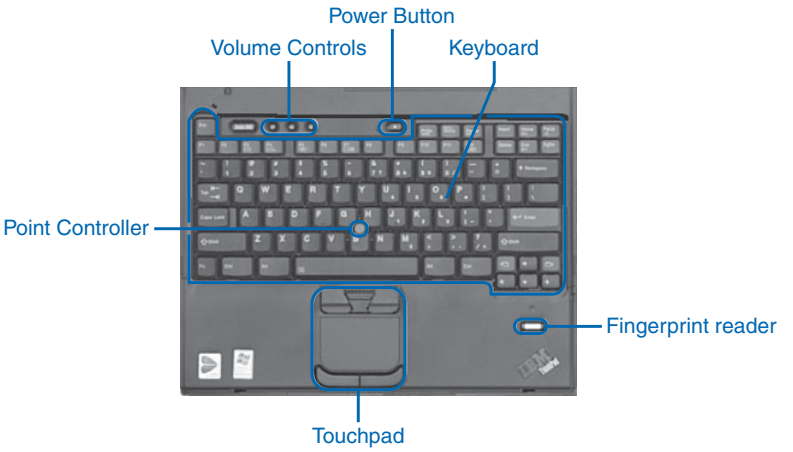
Laptops have a "clamshell" design. Typically, the laptop is closed when not in use. By opening the lid of the laptop, you can access a variety of input devices, LEDs, and a display screen.

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There are several ***input devices*** available when the laptop lid is open, as shown in Figure 6-7:

- ***Volume controls***
- ***Power button***
- ***Keyboard***
- ***Pointer controller***
- ***Fingerprint reader***
- ***Touchpad mouse***

Figure 6-7 Open Laptop



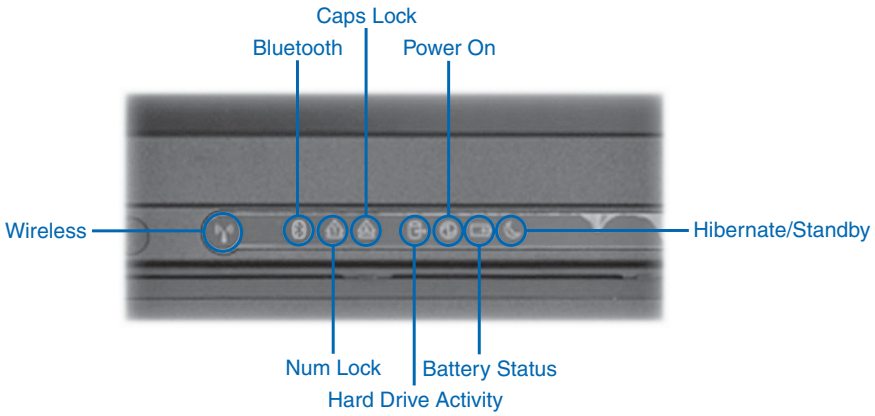
A laptop receives and interprets data in many ways. As a result, the laptop is able to perform a variety of functions.

At the bottom of the screen in Figure 6-8, a row of LEDs shows the status of specific functions:

- ***Wireless***
- ***Bluetooth***
- ***Num Lock***
- ***Caps Lock***
- ***Hard drive activity***
- ***Power on***
- ***Battery status***
- ***Hibernate/standby***

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Figure 6-8 Laptop Status LEDs



Note

Indicators can vary by laptop.

A laptop monitor is a built-in liquid crystal display (LCD). It is similar to a desktop LCD monitor, except that the resolution, brightness, and contrast settings can be adjusted using software or button controls. The laptop monitor cannot be adjusted for height and distance because it is integrated into the lid of the case.

A desktop monitor can be connected to a laptop. Using the ***function key***, you can toggle the screen from the laptop to the desktop monitor or view both at the same time. These key combinations vary from laptop to laptop. Refer to the user manual for directions.



Virtual Laptop Activity: Keyboard

Explore the Virtual Laptop keyboard. Refer to the Virtual Laptop software on the CD that accompanies this book.

Describe the Components Found on the Laptop Docking Station

A ***base station*** is a device that attaches to AC power and to desktop peripherals. When you plug the laptop into the base station, you have convenient access to power and the attached peripherals.

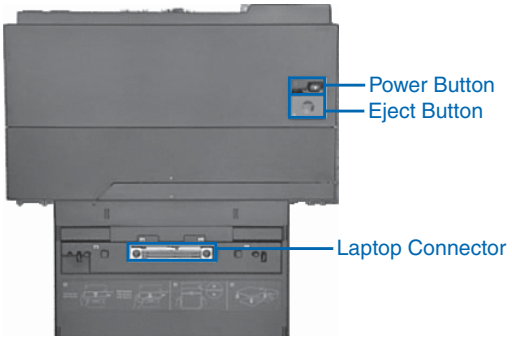
There are two types of base stations: ***docking stations*** and ***port replicators***. Docking stations and port replicators are used for the same purpose. Port replicators are usually smaller than docking stations and do not have speakers or Personal Computer Memory Card International Association (PCMCIA) slots.

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The following are three typical areas on top of the docking station, as shown in Figure 6-9:

- Power button
- ***Eject button***
- ***Laptop connector***

Figure 6-9 Docking Station Top View



Some docking stations include drive bays and ports to provide additional functionality. The back of the docking station contains ports and connectors used to attach to desktop peripherals such as a mouse, a monitor, or a printer. A vent is also necessary to expel hot air from the docking station.

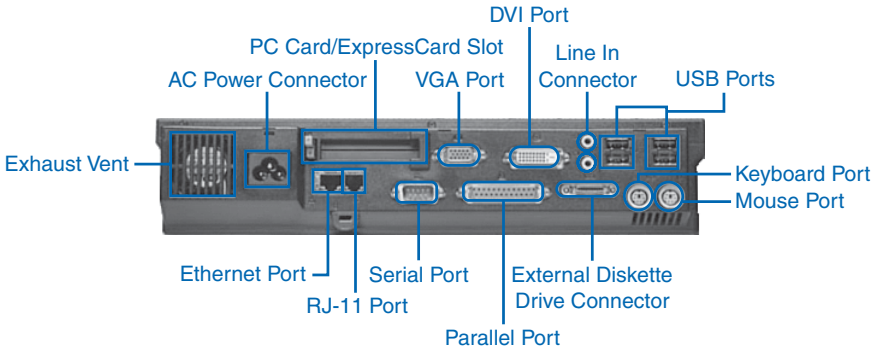
The following components are typically located on the back of the docking station, as shown in Figure 6-10:

- ***Exhaust vent***
- AC power connector
- ***PC Card/ExpressCard slot***
- VGA port
- ***Digital Visual Interface (DVI) port***
- ***Line In connector***
- ***Headphone connector***
- ***USB port***
- ***Mouse port***
- ***Keyboard port***
- ***External diskette drive connector***
- Parallel port

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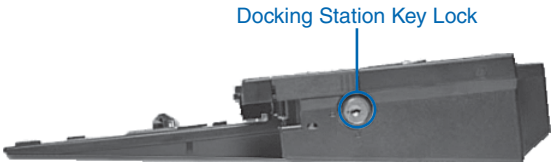
- ***Serial port***
- ***Modem port***
- ***Ethernet port***

Figure 6-10 Docking Station Rear View



Secure the laptop to the docking station with a ***key lock***, as shown in Figure 6-11.

Figure 6-11 Docking Station Key Lock



Worksheet 6.2.3: Complete Docking Stations True or False Questions

Answer true or false statements about docking stations. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this worksheet now or wait until the end of the chapter.

Virtual Laptop Activity: Docking Station

Explore the different views of the docking station in the Virtual Laptop. Refer to the Virtual Laptop software on the CD that accompanies this book.

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Compare and Contrast Desktop and Laptop Components

Most of the functions that a desktop can perform can also be performed by a laptop. However, these two kinds of computers are built very differently and the parts are not interchangeable. As an example, a airplane and a helicopter can each travel to the same destination, but they cannot be repaired with the same spare parts. This is also true for laptops and desktops. Few components can be shared between desktops and laptops.

Desktop components tend to be standardized. They usually meet universal ***form factors***, meaning that desktops made by different manufacturers can often use the same components. A common desktop form factor is Advanced Technology Extended (ATX). When purchasing upgrade parts for this form factor, you will look for ATX motherboards and ATX power supplies. This standard should guarantee that the motherboard and power supply will work in the ATX case. A DVD/CD-RW drive is another example of a desktop component that has a standard form factor.

Laptop components are much more specialized than desktop components. This is because laptop manufacturers focus on refining laptop components to make them more efficient and compact. As a result, manufacturers design laptop components to follow their own specific form factors. Laptop components are proprietary, so you might not be able to use components made by one laptop manufacturer to repair a laptop made by another manufacturer.

Note

Technicians might have to obtain certification for each laptop manufacturer they support.

After completing the following sections, you will meet these objectives:

- Compare and contrast desktop and laptop motherboards
- Compare and contrast desktop and laptop processors
- Compare and contrast desktop and laptop power management
- Compare and contrast desktop and laptop expansion capabilities

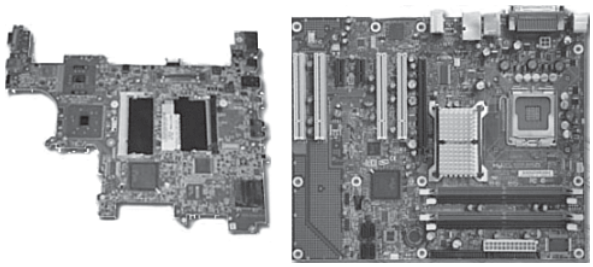
Compare and Contrast Desktop and Laptop Motherboards

Desktop motherboards have standard form factors. The standard size and shape allow motherboards from different manufacturers to be interchangeable.

Laptop motherboards vary by manufacturer and are proprietary. When you repair a laptop, it is strongly recommended that you obtain a replacement motherboard from the manufacturer of the laptop. Figure 6-12 shows a desktop motherboard and a laptop motherboard.

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Figure 6-12 Laptop Motherboard and Desktop Motherboard



Laptop Motherboard

Desktop Motherboard

Laptop motherboards and desktop motherboards are designed differently. Components designed for a laptop generally cannot be used in a desktop.

Compare and Contrast Desktop and Laptop Processors

The central processing unit (CPU), or processor, is the brain of the computer. The CPU interprets and processes instructions that are used to manipulate data.

Laptop processors are designed to use less power and create less heat than desktop processors. As a result, laptop processors do not require cooling devices that are as large as those found in desktops. Laptop processors also use ***CPU throttling*** to modify the clock speed as needed to reduce power consumption and heat. This results in a slight decrease in performance. It also increases the life span of some components. These specially designed processors allow a laptop to operate for a longer period of time when using a battery power source.

Note

Technicians should refer to the laptop manual for processors that can be used as replacement processors and for processor replacement instructions.

Compare and Contrast Desktop and Laptop Power Management

Power management controls the flow of electricity to the components of a computer.

Desktops are usually set up in a location where they remain plugged into a power source. Desktop power management distributes electricity from the source to the components of the desktop. There is also a small battery in the desktop that provides electricity to maintain the internal clock and BIOS settings when the desktop is powered off.

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Laptops are small and portable. This portability feature is achieved by combining the small size and weight of a laptop with the ability to operate from a battery. When the laptop is plugged in, laptop power management sends electricity from the AC power source to the laptop components. The laptop power management also recharges the battery. When the laptop is unplugged, laptop power management takes electricity from the battery and sends it to the laptop components.

There are two methods of power management:

- ***Advanced Power Management (APM)***: APM is an earlier version of power management. With APM, the BIOS was used to control the settings for power management.
- ***Advanced Configuration and Power Interface (ACPI)***: ACPI has replaced APM. ACPI offers additional power management features. With ACPI, the operating system controls power management.

You learn more about APM and ACPI in the section "Describe How to Configure Power Settings," later in this chapter.

Compare and Contrast Desktop and Laptop Expansion Capabilities

Expansion capabilities add functionality to a computer. Many expansion devices can be used with both laptops and desktops:

- External drives
- Modems
- Network cards
- Wireless adapters
- Printers
- Other peripherals

Expansion devices are attached to laptops and desktops differently. A desktop attaches these devices with USB ports and parallel ports. A laptop attaches these devices with USB ports, parallel ports, and PC Cards.

The standardized use of USB and FireWire ports makes it possible to connect many types of external components to laptops, docking stations, port replicators, and desktops. The USB and FireWire standards make it possible to connect and remove external components without the need to power off the system. USB and FireWire ports are used to connect a range of external components:

- Printers
- Scanners

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- Floppy disk drives
- Mice
- Cameras
- Keyboards
- Hard drives
- Flash drives
- Optical drives
- MP3 players

Laptops and desktops have similar expansion capabilities. The difference in form factor between the computers determines which type of expansion device is used. Desktops have internal bays that support 5.25-inch and 3.5-inch drives. Additionally, there is space to install other permanent expansion drives. Laptops have limited space, so the expansion bays on laptops are designed to allow different types of drives to fit into the same bay. Drives are hot swappable and are inserted or removed as needed.

Table 6-2 shows a comparison of desktop and laptop expansion components.

Table 6-2 Laptop and Desktop Expansion Components

	Laptops			Desktops		
Component	**PC Card**	**Integrated**	**External Ports (USB, Parallel, Video, FireWire, Serial)**	**Integrated**	**Adapter Card**	**External Ports (USB, Parallel, Video, FireWire, Serial)**
External monitor			X			X
Printer			X			X
Keyboard		X	X			X
Mouse			X			X
External drives			X			X
Ethernet NIC	X	X	X	X	X	X

continues

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Table 6-2 Laptop and Desktop Expansion Components *continued*

	Laptops			Desktops		
Component	**PC Card**	**Integrated**	**External Ports (USB, Parallel, Video, FireWire, Serial)**	**Integrated**	**Adapter Card**	**External Ports (USB, Parallel, Video, FireWire, Serial)**
Wireless NIC	X	X	X	X	X	X
CD/DVD drives			X			X
Drive controllers		X		X	X	

Laptops use the PC Card slot to add functionality. The PC Card slot uses an open standard interface to connect to peripheral devices using the CardBus standard. Examples of devices that connect using PC Cards include the following:

- Memory
- Modems
- Hard drives
- Network cards

PC Cards follow the PCMCIA standard. They come in three types: Type I, Type II, and Type III. Each type of PC Card is different in size and can attach to different devices. A newer type of PC Card is called the PC ExpressCard.

Table 6-3 shows a comparison of PC Cards.

Table 6-3 PC Card Specifications

PC Bus	Size (mm)	Thickness (mm)	Interface	Examples
Type I	85.6 x 54	3.3	Memory, I/O, CardBus	SRAM flash
Type II	85.6 x 54	5.5	Memory, I/O, CardBus	Modem LAN wireless
Type III	85.6 x 54	10.5	Memory, I/O, CardBus	Hard drive

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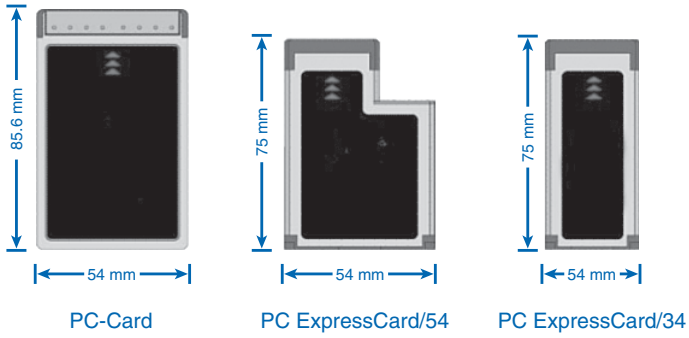
Table 6-4 compares PC ExpressCards.

Table 6-4 PC ExpressCard Specifications

Express Bus	Size (mm)	Thickness (mm)	Interface	Examples
Express Card/34	75 x 34	5	PCI Express or USB 2.0	FireWire, TV tuner, wireless NIC
Express Card/54	75 x 54	5	PCI Express or USB 2.0	Smart Card reader, Compact Flash reader, 1.8-inch disk drive

The PC ExpressCard has 34-pin and 54-pin configurations. Figure 6-13 shows an example of a PC Card and PC ExpressCards.

Figure 6-13 Laptop Expansion Cards



Worksheet 6.3.4: Answer Laptop Expansion Questions

Fill in the table and short answer questions on laptop expansion specifications. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this worksheet now or wait until the end of the chapter.

Explain How to Configure Laptops

To allow applications and processes to run smoothly, you might need to configure and allocate system resources, install additional components and plug-ins, or change environmental settings to match software requirements. Adding external components is usually accomplished through the use of Plug and Play, but occasionally driver installation and additional configuration might be required. Proper configuration of the power settings will help you

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get the maximum performance from a laptop, such as increasing the length of time the laptop can be used on battery power.

With laptops, you might need to exchange components occasionally to accomplish different tasks and respond to changing situations. You can customize a laptop for specific purposes by adding external components. For example, you can install a second hard drive in a laptop to provide additional storage capacity. Components need to be carefully inserted or connected to bays, connectors, and proprietary expansion areas to avoid damage to the equipment. It is important to follow safe removal procedures when disconnecting hot-swappable and non-hot-swappable devices.

After completing the following sections, you will meet these objectives:

- Describe how to configure power settings
- Describe the safe installation and removal of laptop components

Describe How to Configure Power Settings

One of the most popular features of a laptop is the ability to operate using batteries. This feature allows laptops to operate in locations where AC power is not available or is inconvenient. Advances in power management and battery technology are increasing the time laptop users can remain disconnected from AC power. Current batteries can last from 2 to 10 hours without recharging. Managing the power by configuring the power settings on a laptop is important to ensure that the battery charge is used efficiently.

The Advanced Configuration and Power Interface (ACPI) standards create a bridge between the hardware and OS and allow technicians to create power management schemes to get the best performance from the computer. The ACPI standards can be applicable to most computers, but they are particularly important when managing power in laptops. Table 6-5 shows information about each power state.

Table 6-5 Power Management States

ACPI Standard	Power Management State
S0	The computer is on and the CPU is running.
S1	The CPU is not running. However, the CPU and RAM are still receiving power.
S2	The CPU is off, but the RAM is refreshed. The system is in a lower power mode than S1.
S3	The CPU is off, and the RAM is set to slow refresh rate. This mode is often called “Save to RAM.” In Windows XP, this state is known as the Standby mode.

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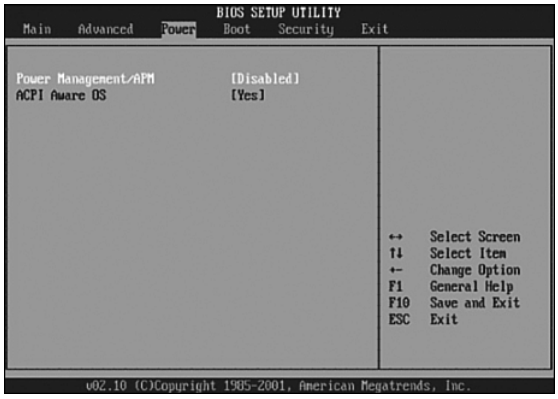
ACPI Standard	Power Management State
S4	The CPU and RAM are off. The contents of RAM have been saved to a temporary file on the hard disk. This mode is also called "Saved to Disk." In Windows XP, this state is known as the Hibernate mode.
S5	The computer is off and nothing has been saved.

Technicians frequently are required to configure power settings by changing the settings found in BIOS. Configuring power settings in BIOS affects the following conditions:

- System states
- Battery and AC modes
- Thermal management
- CPU PCI bus power management

Figure 6-14 shows an example of power settings in BIOS.

Figure 6-14 BIOS Settings



Note

When working in Windows XP, the ACPI power management mode must be enabled in BIOS to allow the OS to configure all the power management states. There is no standard name for each power management state. Manufacturers can use different names for the same state.

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Here are the steps to check the ACPI settings in the BIOS:

How To

Step 1. Enter BIOS setup by pressing the appropriate key or key combination while the computer is booting. Typically this is the Delete key or the F2 key, but there are several other options.

Step 2. Locate and enter the Power Management Settings menu item.

Step 3. Use the appropriate keys to enable ACPI mode.

Step 4. Save and exit BIOS setup.

Note

These steps are common to most laptops and should be used only as a guideline. Be sure to check your laptop manual for specific configuration settings.

The ***power options*** in Windows XP allow you to reduce the power consumption of a number of devices or of the entire system. Power options allow you to control the power management features of the following:

- Hard drive
- Display
- Shut Down, Hibernate, and Standby modes
- Low-battery warnings

Configuring Power Settings in Windows XP

You can adjust power management by using Power Options windows in the Control Panel. The Power Options in the Control Panel display the only options that can be controlled.

Note

Power Options will automatically detect devices that might be unique to your computer. Therefore, the Power Options windows can vary by the hardware that is detected.

To configure your power settings, choose **Start** > **Control Panel** > **Power Options.**

Configuring Power Schemes

Power schemes are a collection of settings that manage the power usage of the computer. Both the hard drive and the display consume large amounts of power. They can be configured on the Power Schemes tab.

When you open Power Options, you will notice that Windows XP has preset power schemes. These are the default settings and were created when Windows XP was installed. You can use the default power schemes or create customized schemes that are based on specific work requirements. Figure 6-15 shows the default power scheme set for a laptop.

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Figure 6-15 Power Options Properties



Customizing the Display and Hard Drive Power Settings

You can customize the display and hard drive power settings depending on your requirements and save the power scheme with a customized name. For example, a student uses a laptop for research on the Internet but does not create or save files often. In this scenario, the student needs access to the display, but rarely accesses the hard drive. The student customizes the settings as shown in Figure 6-16 and saves the settings as Research.

Figure 6-16 Power Scheme: Research Settings



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Power Management for the Hard Drive

One of the biggest power consumers on a laptop is the hard drive. In this scenario, the hard drive is not accessed often. The **Turn off hard disks** time is set for 1 hour when the laptop is plugged in and 3 minutes when the laptop is running on batteries.

The student decides that the default settings for the Standby and Hibernate modes are acceptable and no changes are made.

Setting the Laptop to the Standby or Hibernate Sleep State

If you do not want to completely shut down the laptop, you have two options:

- ***Standby***: Documents and applications are saved in RAM, allowing the computer to power on quickly.
- ***Hibernate***: Documents and applications are saved to a temporary file on the hard drive, and it will take a little longer than Standby to power on.

Figure 6-17 shows Hibernate enabled in the Power Options properties.

Figure 6-17 Hibernate Options

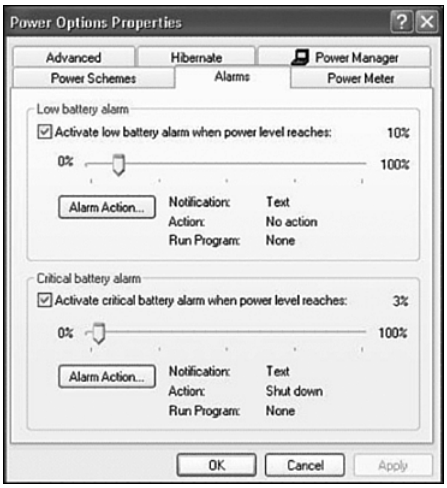


Adjusting Low Battery Warnings

In Windows XP, you can set the low battery warnings. There are two levels: Low Battery Alarm and Critical Battery Alarm. The ***low battery alarm*** will warn you that the battery is low. The ***critical battery alarm*** will initiate a forced standby, hibernate, or shutdown, as shown in Figure 6-18.

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Figure 6-18 Critical Battery Alarm Actions





Worksheet 6.4.1: Match ACPI Standards

Match the ACPI standard to the correct characteristic. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this worksheet now or wait until the end of the chapter.

Describe the Safe Installation and Removal of Laptop Components

There are a number of components on a laptop that might need to be replaced. Remember always to make sure that you have the correct replacement component and tools as recommended by the manufacturer. Some components are ***hot-swappable***, which means that you can remove and replace them while the computer is on. Some components that you might need to replace include the following:

- Battery
- Optical drive
- Hard drive
- Memory
- PC cards

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Caution

Each laptop manufacturer uses unique hardware installation and removal procedures. Check the laptop manual for specific installation information, and follow safety installation and electrostatic discharge (ESD) precautions.

Always disconnect power and remove the battery before installing or removing laptop components that are not hot-swappable. On some laptops, the PC Card, optical drive, and USB devices are hot swappable. However, the internal hard drive, RAM, and battery are *not* hot swappable.

To replace the battery, follow these steps:



Step 1. Move the battery lock to the unlocked position.

Step 2. Hold the release lever in the unlock position and remove the battery.

Step 3. Insert the replacement battery into the battery bay.

Step 4. Make sure that both battery levers are locked.

To replace the optical drive, follow these steps:



Step 1. Press the button to open the drive and remove any media in the drive. Close the tray.

Step 2. Slide the latch to release the lever that secures the drive.

Step 3. Pull on the lever to expose the drive. Remove the drive.

Step 4. Insert the replacement drive securely.

Step 5. Push the lever inward.

To replace the hard drive, follow these steps:



Step 1. On the bottom of the laptop, remove the screw that holds the hard drive in place.

Step 2. Slide the assembly outward and remove it.

Step 3. Remove the hard drive face plate from the hard drive.

Step 4. Attach the hard drive face plate to the replacement hard drive.

Step 5. Slide the hard drive into the hard drive bay.

Step 6. On the bottom of the laptop, install the screw that holds the hard drive in place.

Follow these steps to remove the existing expansion memory, also called ***Small Outline Dual In-line Memory Module (SODIMM)***, if there are no available slots for the new SODIMM:



Step 1. Remove the screw to expose the SODIMM.

Step 2. Press outward on the clips that hold the sides of the SODIMM.

Step 3. Lift to loosen the SODIMM from the slot and remove the SODIMM.

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Step 4. Install the replacement SODIMM by aligning the notch at a 45-degree angle.

Step 5. Gently press down until the clips lock.

Step 6. Replace the cover and install the screw.

To replace the PC card, follow these steps:



Step 1. Press the top eject button to release the PC expansion card.

Note

There are two buttons. The bottom blue button ejects the Type II PC card.

Step 2. Press the blue button inward.

Step 3. Insert the replacement PC expansion card into the express slot.

To remove hot-swappable devices, follow these steps:



Step 1. Click the **Safely Remove Hardware** icon in the Windows system tray to ensure that the device is not in use.

Step 2. Click the device you want to remove. A message pops up to tell you that it is safe to remove the device.

Step 3. Remove the hot-swappable device from the laptop.



Virtual Laptop Activity: Components and Devices

Replace components and devices in the Virtual Laptop. Refer to the Virtual Laptop software on the CD that accompanies this book.

Compare the Different Mobile Phone Standards

When people began to use cell phones, there were few industry-wide standards applying to cell phone technology. Without standards, it was difficult and expensive to make calls to people that were on another network. Today, cell phone providers use industry standards, which make it easier to use cell phones to make calls.

When the industry started, most cell phone standards were analog. Today, cell phone standards are mostly digital.

Note

Cell phone standards have not been adopted uniformly around the world. Some cell phones are capable of using multiple standards while others can use only one standard. As a result, some cell phones can operate in many countries while other cell phones can only be used locally.

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The first generation (1G) of cell phones began service in the 1980s. First-generation phones primarily used analog standards, including Advanced Mobile Phone System (AMPS) and Nordic Mobile Telephone (NMT).

In an ***analog*** system, the voice information is sent by varying the radio signals used by the phone in the same pattern as the speakers' voices. Unfortunately, this means that interference and noise, which also vary the signal, cannot easily be separated from the voice in the signal. This limits the usefulness of analog systems.

Digital signals convert the speakers' voices into a digital signal that uses a chain of 1s and 0s. This degrades the signal a little, because 1s and 0s are not a faithful representation of your voice. However, the digital signal is robust. It can be fixed using error correction routines if there is interference. Also, digital signals can be compressed, making the systems much more efficient than analog systems.

In the 1990s, the second generation (2G) of cell phones was marked by a switch from analog to digital standards. Second-generation cell standards included Global System for Mobile (GSM), Integrated Digital Enhanced Network (iDEN), and Code Division Multiple Access (CDMA).

Third-generation (3G) standards enable cell phones to go beyond simple voice and data communications. It is now common for cell phones to send and receive text, photos, and video. It is also common for 3G cell phones to access the Internet and to use the Global Positioning System (GPS).

Note

As 3G cell phone standards were being developed, extensions to the existing 2G standards were added. These transitional standards are known as 2.5G standards.

Fourth-generation (4G) standards have been championed by many users because of the availability of increased data rates. Higher data rates will allow users to download files, such as video and music, faster than what was available with standards of previous generations.

Table 6-6 shows more information about the different cell phone standards.

Table 6-6 Cell Phone Standards

Generation	Standard Name	Features	Used In
1G (Analog cell phone standards introduced in the 1980s)	Nordic Mobile Telephone (NMT)	Replaced wired telephones	Saudi Arabia, Scandinavia
	Advanced Mobile Phone System (AMPS)	Replaced wired telephones	United States, New Zealand

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Generation	Standard Name	Features	Used In
2G (Digital cellular)	GSM communications	Digital-quality calls everywhere	Worldwide
	iDEN	Push-To-Talk service, international roaming	North and South America, Philippines, Singapore, Saudi Arabia
2.5G (Digital cellular + packet network for data)	General Packet Radio Service (GPRS)	Data layer for GSM	Worldwide
	Code Division Multiple Access (CDMA) CDMA2000 1xRTT/IS-2000	Unified Digital Data, Voice service	North and South America, India, Indonesia, Japan, South Korea
	EDGE (CDMA) Enhanced Data Rates for Global Evolution	Data upgrade to GPRS	Worldwide
3G (Simultaneous voice and data, with e-mail and instant messaging)	Universal Mobile Telecommunications System (UMTS, also called 3GSM)	Advanced GSM phone system	Europe, Africa, Asia, U.S.
	1xEV-DO/IS-856 (Pronounced D-O)	Advanced CDMA telephone system	Worldwide
4G (Technologies that are “3G and beyond”)	High Speed Downlink Packet Access (HSDPA)	Advanced UMTS system for voice, high-speed data	Worldwide

New technologies that add multimedia and networking functionality can be bundled with cell phone standards. Table 6-7 lists common technologies that can be added to the cell phone bundle of services. Most cell phone providers charge extra for adding these features.

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Table 6-7 Internet Standards

Internet Standard	Purpose
Short Message Service (SMS)	Used for text messaging
Multimedia Message Service	Used for sending and receiving photos and videos
Packet switching	Used for accessing the Internet

Identify Common Preventive Maintenance Techniques for Laptops and Portable Devices

Because laptops are mobile, they are used in different types of environments. Some environments can be hazardous to a laptop. Even eating or drinking around a laptop creates a potentially hazardous condition.

Consider what would happen if a drink were spilled onto the keyboard of a laptop. Many components are placed in a very small area directly beneath the keyboard. Spilling liquid or dropping debris onto the keyboard can result in severe internal damage.

It is important to keep a laptop clean and to ensure that it is being used in the most optimal environment. The following sections cover preventive maintenance techniques for the laptop.

After completing these sections, you will meet these objectives:

- Identify appropriate cleaning procedures
- Identify optimal operating environments

Identify Appropriate Cleaning Procedures

Proper routine cleaning is the easiest, least expensive way to protect and to extend the life of a laptop. It is very important to use the right products and procedures when cleaning a laptop. Always read all warning labels on the cleaning products. The components are very sensitive and should be handled with care. Consult the laptop manual for additional information and cleaning suggestions. This section provides basic steps for cleaning the laptop keyboard, ventilation area, screen, touchpad, disk drives, and discs.

To clean a laptop keyboard, perform the following procedures:

How To

Step 1. Turn off the laptop.

Step 2. Disconnect all attached devices.

Step 3. Disconnect laptop from the electrical outlet.

Step 4. Remove all installed batteries.

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Step 5. Blow compressed air between the keys.

Step 6. Wipe laptop and keyboard with a soft, lint-free cloth lightly moistened with water or computer-screen cleaner.

To clean the ventilation area, perform the following procedures:



Step 1. Turn off the laptop.

Step 2. Disconnect all attached devices.

Step 3. Disconnect laptop from the electrical outlet.

Step 4. Remove all installed batteries.

Step 5. Use compressed air or a nonelectrostatic vacuum to clean out the dust from the vents and the fan behind the vent.

Step 6. Use tweezers to remove any debris.

To properly clean an LCD screen, perform the following procedures:



Step 1. Turn off the laptop.

Step 2. Disconnect all attached devices.

Step 3. Disconnect laptop from the electrical outlet.

Step 4. Remove all installed batteries.

Step 5. Wipe display with a soft, lint-free cloth lightly moistened with water or LCD cleaner.

Caution

Do not spray cleaning solution directly onto the LCD. Use products specifically designed for cleaning LCD screens.

To clean the touchpad on a laptop, perform the following procedures:



Step 1. Turn off the laptop.

Step 2. Disconnect all attached devices.

Step 3. Disconnect laptop from the electrical outlet.

Step 4. Remove all installed batteries.

Step 5. Wipe surface of touchpad gently with a soft, lint-free cloth moistened with an approved cleaner. Never use a wet cloth.

Caution

Use a soft, lint-free cloth with an approved cleaning solution to avoid damaging laptop surfaces. Apply the cleaning solution to the lint-free cloth, not directly to the laptop.

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To clean a floppy drive, use a commercially available cleaning kit. Floppy drive cleaning kits include pretreated floppy disks that remove contaminants from the floppy drive heads that have accumulated through normal operation. To clean the drive, follow these steps:



Step 1. Remove all media from the floppy drive.

Step 2. Insert the cleaning disk and let it spin for the suggested amount of time.

Dirt, dust, and other contaminants can collect in your optical drives and on the discs. Contaminated drives and discs can cause malfunctions, missing data, error messages and lost productivity. To clean an optical disc, use a commercially available CD or DVD drive cleaning disc. Many floppy disk cleaning kits include an optical disc cleaner. Like the floppy disk cleaner, optical disc cleaner kits contain a cleaning solution and a nonabrasive disc that is inserted into the optical drive. Perform the following cleaning procedures:



Step 1. Remove all media from the optical drive.

Step 2. Insert the cleaning disc and let it spin for the suggested amount of time to clean all contact areas.

For a CD or DVD disc, inspect the disc for scratches. Replace discs that contain deep scratches because they can cause data errors. If you notice problems such as skipping or degraded playback quality with your CDs or DVDs, clean the discs. Commercial products are available that clean discs and provide protection from dust, fingerprints, and scratches. Cleaning products for CDs are safe to use on DVDs. To clean the disc, follow these steps:



Step 1. Hold the disc by its outer edge or by the inside edge of the center hole.

Step 2. Gently wipe the disc with a lint-free cotton cloth. Never use paper or any material that can scratch the disc or leave streaks.

Step 3. Wipe from the center of the disc outward. Never use a circular motion.

Step 4. Apply a commercial CD or DVD cleaning solution to the lint-free cotton cloth, and wipe again if any contaminates remain on the disc.

Step 5. Allow the disc to dry before it is inserted into the drive.

Identify Optimal Operating Environments

An ***optimal operating environment*** for a laptop is clean, free of potential contaminants, and within the temperature and humidity range specified by the manufacturer. With most desktop computers, the operating environment can be controlled. However, because of the portable nature of laptops, it is not always possible to control the temperature, humidity, and working conditions. Laptops are built to resist adverse environments, but technicians should always take precautions to protect the equipment from damage and loss of data.

It is important to transport or ship laptops carefully. Use a padded laptop case to store your laptop. When you carry it, use an approved computer bag. If the laptop is shipped, use

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sufficient packing material to prevent damage during transport. Figure 6-19 shows examples of laptop carrying cases and packing boxes.

Figure 6-19 Shipping and Transporting a Laptop



Laptops are transported to many types of environments. Dust particles, temperature, and humidity can affect the performance of a laptop. Follow these guidelines to help ensure optimal operating performance from your laptop:

- Clean the laptop frequently to remove dust and potential contaminants.
- Do not obstruct vents or airflow to internal components. A laptop can overheat if air circulation is obstructed.
- Keep the room temperature between 45 and 90 degrees Fahrenheit (7 and 32 degrees Celsius).
- Keep the humidity level between 10 and 80 percent.

Temperature and humidity recommendations will vary by laptop manufacturer. You should research these recommended values, especially if you plan to use the laptop in extreme conditions.

Describe How to Troubleshoot Laptops and Portable Devices

When troubleshooting problems with laptops or portable devices, you should determine whether a repair is cost effective. To determine the best course of action, you should compare the cost of the repair to the replacement cost of the laptop or portable device, less the salvage value.

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Because many portable devices change rapidly in design and functionality, portable devices are often more expensive to repair than to replace. For this reason, portable devices are usually replaced while laptops can be replaced or repaired.

Follow the steps outlined in the following sections to accurately identify, repair, and document the problem. The troubleshooting process follows:



Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

After completing these sections, you will meet these objectives:

- Review the troubleshooting process
- Identify common problems and solutions

Review the Troubleshooting Process

The first step in the troubleshooting process is to gather data as follows from the customer. There are two types of questions you can ask: open-ended and closed-ended.

Open-ended questions cannot be answered with yes or no answers. The purpose of open-ended questions is to allow the customer to describe the problem.

Closed-ended questions can usually be answered with yes or no answers. This type of question can help a technician focus in on an error and locate the exact problem when a potential solution is being tested.

After you have talked to the customer, you should verify the obvious issues. Examine the most obvious causes of a problem as follows:

- Battery
- LEDs
- Function keys
- Cable connections

After the obvious issues have been verified, try some quick solutions such as

- Reboot the laptop.
- Check the BIOS settings.

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- Disconnect peripherals.
- Use the Last Know Good Configuration option.

If quick solutions did not correct the problem, gather data from the computer. Use the following tools to gather information from the computer:

- System Properties
- Device Manager
- Network Settings
- Power Options
- Event Viewer
- Operating system information
- Error messages
- Beep sequences

The next step in the troubleshooting process is to evaluate the information you have from the customer and from the laptop, determine possible solutions, and implement the best one:

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

After you have solved the laptop problem, you will close with the customer.

When you are confident that the problem has been resolved, the next step is to close with the customer as follows:

- Discuss the solution implemented with the customer.
- Have the customer verify that the problem has been solved.
- Provide the customer with all paperwork.
- Document the steps taken to solve the problem in the work order and the technician's journal.

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- Document any components used in the repair.
- Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Computer problems can be attributed to hardware, software, networks, or some combination of the three. You will resolve some types of computer problems more often than others. Table 6-8 addresses some common problems and solutions for laptops and portable devices.

Table 6-8 Common Problems and Solutions for Laptops and Portable Devices

Problem Symptom	Possible Solution
LCD laptop screen is not displaying anything.	Disconnect any external monitors and use the function key sequence to activate the LCD.
Image on the LCD screen is too dim.	Swap the laptop to AC power and adjust brightness controls for the LCD.
Image on the LCD screen contains a black border.	Adjust display resolution settings.



Worksheet 6.7.2: Research Laptop Problems

Research laptop issues. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this worksheet now or wait until the end of the chapter.

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Summary

This chapter discussed the features of laptops, portable devices (PDAs), and smartphones. The following are some of the important concepts to remember from this chapter:

- Laptops, PDAs, and smartphones are becoming increasingly popular because of reduced costs, lighter weights, increased capabilities, and battery power for portability.
- Laptops and desktops have ports that are virtually the same, so peripherals are interchangeable. Laptops can use docking stations or port replicators to quickly connect to desktop peripherals and AC power.
- The laptop CPU is designed to use less power and create less heat than the desktop computer. It uses CPU throttling to reduce power consumption and heat.
- Functionality of the laptop can be expanded by adding components through PC Card or ExpressCard slots and USB, FireWire, and parallel ports.
- Cell phone standards were developed in the 1980s. The current third-generation standards enable cell phones to share some laptop functions, such as e-mail, Internet access, and calendar and address functions. Standards have not been adopted worldwide.
- Preventive maintenance will ensure optimal operation of the laptop. It is important to keep the laptop clean and in safe environments. It is critical to use the correct materials and techniques when cleaning the various components of a laptop. Procedures for cleaning the components are presented.
- Dust, temperature, and humidity can affect laptop performance. Basic guidelines are to keep the laptop clean, with good ventilation and room temperature at 45 to 90 degrees F (7 to 32 degrees C) and humidity levels in the range of 10 to 80 percent.
- Troubleshooting laptop problems requires the technician to identify, repair, and document the problem. Troubleshooting steps include gathering data from the customer, verifying the obvious, trying quick solutions first, gathering data from the computer, evaluating the problem, implementing the solution, and closing with the customer.

Chapter 13, “Advanced Laptops and Portable Devices,” focuses on troubleshooting more difficult problems.

Summary of Exercises

This is a summary of the Labs, Worksheets, Remote Technician exercises, Class Discussions, Virtual Desktop activities, and Virtual Laptop activities associated with this chapter.

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Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Worksheet 6.1.2: Research Laptops, Smartphones, and PDAs

Worksheet 6.2.3: Complete Docking Stations True or False Questions

Worksheet 6.3.4: Answer Laptop Expansion Questions

Worksheet 6.4.1: Match ACPI Standards

Worksheet 6.7.2: Research Laptop Problems



Virtual Laptop Activities

The following Virtual Laptop activities cover material from this chapter. Refer to the Virtual Laptop software on the CD that accompanies this book.

Virtual Laptop Activity: Explore Laptop

Virtual Laptop Activity: Keyboard

Virtual Laptop Activity: Docking Station

Virtual Laptop Activity: Components and Devices

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. A newer type of PC Card is called the _____.
   a. ExpressCard
   b. PC Card disk
   c. PC CardBus
   d. PCMCIA Card

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2. The PC ExpressCard has _____ and _____ pin configurations.

   a. 64 and 128
   b. 34 and 54
   c. 28 and 40
   d. 9 and 15

3. Which power mode would you use on a laptop running Windows XP to minimize power consumption by reducing power to the hardware?

   a. Network
   b. Hibernate
   c. Active
   d. Conserving

4. When you are ready to clean a laptop's LCD, which of the following would you select?

   a. Trichloroethane solvent
   b. Ammonia-based solvent
   c. A window cleaning solvent
   d. Isopropyl alcohol and water

5. Which of the following is similar to a port replicator, as well as adds more functionality with additional drives?

   a. USB hub
   b. Docking station
   c. Drive bay
   d. Storage area

6. Which of the following features make laptops a good alternative to desktop computers? (Choose two.)

   a. Compact design
   b. Lower costs
   c. Enhanced capabilities
   d. Portability

7. Which laptop device is commonly hot-swappable?

   a. Display
   b. Internal hard drive
   c. PC Card
   d. RAM

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8. Which type of memory is used in laptops?

a. DIMM
b. RIMM
c. SIMM
d. SODIMM

9. Which power management control was introduced prior to the Advanced Configuration and Power Interface?

a. ACCI
b. ACPI
c. AMD
d. APM
e. APA

10. What do FireWire and USB devices have in common?

a. Only one of these devices can be used at a time.
b. They are considered hot-swappable devices.
c. They cannot be used with desktop PCs.
d. They are parallel communication devices.

11. What should a user do when operations on a USB memory device have been completed and it is necessary to remove it from the laptop computer?

a. Reboot the computer.
b. Choose **Start** > **Control Panel** > **System**. Select **USB Device** and then the **Properties** tab. Click **Remove**.
c. Click the **Safely Remove Hardware** icon in the Windows system tray.
d. Just remove the USB device from the computer.

12. Which of the following steps are recommended when cleaning a laptop LCD screen? (Choose two.)

a. Clean the display screen using tissue moistened with water.
b. Disconnect all devices attached to the laptop prior to cleaning the display screen.
c. Power off the laptop prior to cleaning the display screen.
d. Remove all sources of power immediately after cleaning the display screen.
e. Remove the LCD screen from the laptop.

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13. What is the easiest, least expensive way to extend the life of a laptop and keep it in optimal working order?

a. Replace parts regularly.

b. Clean the laptop regularly.

c. Do a clean reinstall of the OS.

d. Back up important information monthly.

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CHAPTER 7

Fundamental Printers and Scanners

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- What types of printers are currently available?
- What is the process of installation and configuration for printers?
- What types of scanners are cu***rrently ava***ilable?
- What is the process of installation and configuration for scanners?
- How can I identify and apply common preventive maintenance techniques to printers and scanners?
- How can I troubleshoot printers and scanners?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

printer *page xx*

scanner *page xx*

electrophotographic technology *page xx*

inkjet printer *page xx*

dot-matrix printer *page xx*

dots per inch (dpi) *page xx*

mean time between failures (MTBF) *page xx*

serial data transfer *page xx*

parallel data transfer *page xx*

Small Computer System Interface (SCSI) *page xx*

Universal Serial Bus (USB) *page xx*

FireWire *page xx*

Ethernet *page xx*

wireless *page xx*

laser printer *page xx*

cleaning *page xx*

conditioning *page xx*

writing *page xx*

developing *page xx*

transferring *page xx*

fusing *page xx*

primary corona wire *page xx*

impact printer *page xx*

thermal *page xx*

piezoelectric *page xx*

solid-ink printer *page xx*

thermal printer *page xx*

dye-sublimation printer *page xx*

continues

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continued

firmware *page xx*

all-in-one *page xx*

flatbed *page xx*

drum *page xx*

handheld *page xx*

optical character recognition (OCR) *page xx*

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This chapter provides essential information about printers and scanners. You will learn how printers operate, what to consider when purchasing a printer, and how to connect printers to an individual computer or to a network.

Printers produce paper copies of electronic files. ***Scanners*** allow users to convert paper documents into electronic files. Many government regulations require physical records; therefore, hard copies of computer documents are often as important today as they were when the paperless revolution began several years ago.

You must understand the operation of various types of printers and scanners to be able to install and maintain them, as well as to troubleshoot any problems that may arise.

Describe the Types of Printers Currently Available

As a computer technician, you might be required to purchase, repair, or maintain a printer. The customer might request that you perform the following tasks:

- Select a printer
- Install and configure a printer
- Troubleshoot a printer

After completing this section, you will meet these objectives:

- Describe characteristics and capabilities of printers.
- Describe printer-to-computer interfaces.
- Describe laser printers.
- Describe impact printers.
- Describe inkjet printers.
- Describe solid-ink printers.
- Describe other printer types.

Describe Characteristics and Capabilities of Printers

Printers available today are usually either laser printers using ***electrophotographic technology*** or ***inkjet printers*** using electrostatic spray technology. ***Dot-matrix printers*** using impact technology are used in applications that require carbon copies. When selecting a printer, consider the following criteria:

- Capacity
- Speed
- Color
- Quality

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- Reliability
- Cost

Capacity and Speed

Printer capacity and speed are factors to consider when selecting a printer. Inkjet printers are usually slower, but they might be adequate for a home or small office. A printer's speed is measured in pages per minute (ppm). The speed of an inkjet printer is 2 to 6 ppm. The speed of a laser printer is 8 to 200 ppm.

Color or Black and White

A computer monitor produces colors through the additive mixing of dots that are displayed on the screen. The eye picks up the colors directly. The dots produce the color range using red, green, and blue (RGB) dots.

A printer produces colors using subtractive mixing. The eye sees a color that reflects from the combination of colors on the paper.

The choice between a black-and-white printer and a color printer depends on your customer's needs. If your customer is primarily printing letters and does not need color capability, a black-and-white printer is sufficient. However, an elementary school teacher might need a color printer to add excitement to lessons.

Quality

The quality of printing is measured in ***dots per inch (dpi)***. The more dpi, the higher the resolution. When the resolution is higher, text and images are usually clearer. To produce the best high-resolution images, you should use both high-quality ink or toner and high-quality paper.

Reliability

A printer should be reliable. Because there are so many types of printers on the market, you should research the specifications of several printers before selecting one. Here are some of the options available from the manufacturer:

- **Warranty:** Identify what is covered in the warranty.
- **Scheduled servicing:** Servicing is based on expected usage. Information is found in the manual or on the manufacturer's website.
- ***Mean time between failures (MTBF)*:** The average length of time that the printer will work without failing. You typically can find this information in the manual or on the manufacturer's website.

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Total Cost of Ownership

Consider the cost when selecting hardware. When buying a printer, you must consider more than just the initial cost of the printer. The total cost of ownership (TCO) includes a number of factors:

- Initial purchase price
- Cost of supplies, such as paper and ink/toner
- Price per page
- Maintenance costs
- Warranty costs
- Data/communication cables
- The amount of material printed
- Lifetime of the printer

Describe Printer-to-Computer Interfaces

A computer must have a compatible interface with the printer to be able to print documents. Typically, printers connect to home computers using a parallel, USB, or wireless interface. Corporate printers may connect to a network using a network cable.

The different types of printer ports are described in the following sections.

Serial Ports

Serial data transfer is the movement of single bits of information in a single cycle. A serial connection can be used for dot-matrix printers because they do not require high-speed data transfer.

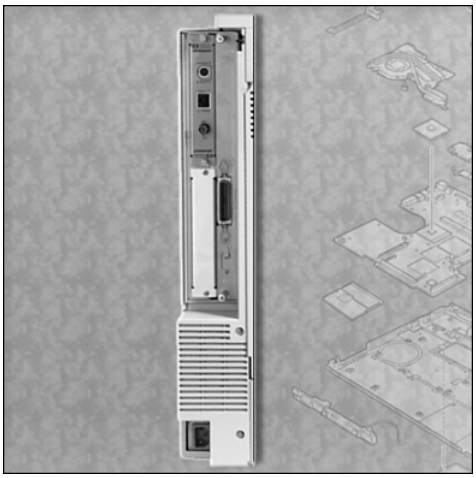
Parallel Ports

Parallel data transfer is faster than serial data transfer. Parallel data transfer is the movement of multiple bits of information in a single cycle. The path is wider for information to move to or from the printer.

IEEE 1284 is the current standard for parallel printer ports. Enhanced Parallel Port (EPP) and Enhanced Capabilities Port (ECP) are two modes of operation within the IEEE 1284 standard that allow bidirectional communication. Figure 7-1 shows a parallel port.

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Figure 7-1 Printer Parallel, Ethernet, and Coaxial Ports



SCSI Interfaces

Small Computer System Interface (SCSI) is a type of interface that uses parallel communication technology to achieve high data-transfer rates.

USB Interfaces

Universal Serial Bus (USB) is a common interface for printers and other devices. The speed and simple setup have made USB very practical. Newer operating systems offer "plug-and-play" USB support. When a USB device is added to a computer system supporting plug-and-play, the device is automatically detected and starts the driver installation process.

USB 2.0 is the current USB standard. USB 2.0 can support up to 127 devices and has a transfer rate of as much as 480 Mbps.

FireWire Connections

FireWire, also known as i.LINK or IEEE 1394, is a high-speed communication bus that is platform-independent. FireWire connects digital devices such as digital printers, scanners, digital cameras, and hard drives.

FireWire allows a peripheral device, such as a printer, to seamlessly plug into a computer. It also allows a device such as a printer to be hot-swappable. FireWire provides a single plug-and-socket connection that can attach up to 63 devices. FireWire has a data transfer rate of up to 400 Mbps.

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Ethernet Connections

Printers can be shared over a network. Connecting a printer to the network requires cabling (such as ***Ethernet***) that is compatible with both the existing network and the network port installed in the printer. Most network printers use an RJ-45 interface to connect to a network.

Wireless Connections

Wireless printing technology is available in infrared, Bluetooth, and wireless fidelity (Wi-Fi) technology.

For infrared communication to take place between a printer and a computer, transmitters and receivers are required on both devices. There must be a clear line of sight between the transmitter and receiver on both devices, with a maximum distance of 12 feet (3.7 m). Infrared uses a type of light that is invisible to the human eye.

Bluetooth technology uses an unlicensed radio frequency for short-range communication and is popular for wireless headsets and synching PDAs to laptops and desktop computers. A Bluetooth adapter allows a Bluetooth device to connect to a printer, usually by using a USB port.

Wi-Fi is the popular name for a relatively new technology that lets you connect computers to a network without using cables. Wi-Fi technology has four common standards, all of which begin with the number of the IEEE standard, 802.11:

- 802.11a transfers data at a rate of up to 54 Mbps at 5 GHz.
- 802.11b transfers data at a rate of 11 Mbps at 2.4 GHz.
- 802.11g transfers data at a rate of 54 Mbps at 2.4 GHz. 802.11g products are backward-compatible with 802.11b.
- 802.11n is currently in the standardization process and is expected to be approved with a maximum data transfer rate of up to 248 Mbps.

Describe Laser Printers

A ***laser printer***, such as the one shown in Figure 7-2, is a high-quality, fast printer that uses a laser beam to create an image. The central part of the laser printer is its electrophotographic drum. The drum is a metal cylinder that is coated with a light-sensitive insulating material. When a beam of laser light strikes the drum, it becomes a conductor at the point where the light hits it. As the drum rotates, the laser beam draws an electrostatic image on the drum, called the image. The undeveloped or latent image is passed by a supply of dry ink or toner that is attracted to it. The drum turns and brings this image into contact with the paper, which attracts the toner from the drum. The paper is passed through a fuser that is made up of hot rollers, which melts the toner into the paper.

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Figure 7-2 Laser Printer



The laser printer process involves six steps to print information on a single sheet of paper:

How To

Step 1. ***Cleaning*****:** When an image has been deposited on the paper and fusion occurs, any remaining toner must be removed from the drum. A printer may have a blade that scrapes all excess toner from the drum. Some printers use AC voltage on a wire that removes the charge from the drum surface and allows the excess toner to fall away from the drum. The excess toner is stored in a used-toner container that may be emptied or discarded.

Step 2. ***Conditioning*****:** This step involves removing the old latent image from the drum and conditioning the drum for a new latent image. Conditioning is done by placing a special wire, grid, or roller that receives a negative charge of approximately –600 volts DC uniformly across the surface of the drum. The charged wire or grid is called the ***primary corona wire***. The roller is called a conditioning roller.

Step 3. ***Writing*****:** The writing process involves scanning the photosensitive drum with the laser beam. Every portion of the drum that is exposed to the light has the surface charge reduced to about –100 volts DC. This electrical charge has a lower negative charge than the remainder of the drum. As the drum turns, an invisible latent image is created on the drum.

Step 4. ***Developing*****:** In the developing phase, the toner is applied to the latent image on the drum. The toner is a negatively charged combination of plastic and metal particles. A control blade holds the toner at a microscopic distance from the drum. The toner then moves from the control blade to the more positively charged latent image on the drum.

Step 5. ***Transferring*****:** In this step, the toner attached to the latent image is transferred to the paper. The transfer, or secondary corona, places a positive charge on the paper. Because the drum was charged negatively, the toner on the drum is attracted to the paper. The image is now on the paper and is held in place by the positive charge.

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Step 6. ***Fusing*:** In this step, the toner is permanently fused to the paper. The printing paper is rolled between a heated roller and a pressure roller. As the paper moves through the heated roller and the pressure roller, the loose toner is melted and fused with the fibers in the paper. The paper is then moved to the output tray as a printed page.

The following mnemonic will help you memorize the order of the steps of the laser printing process:

Continuous (cleaning)

Care (conditioning)

Will (writing)

Delay (developing)

Trouble (transferring)

Forever (fusing)

Warning

The primary corona wire or grid, or the conditioning roller, can be very dangerous. The voltage runs as high as –6000 volts. Only certified technicians should work on the unit. Before working inside a laser printer, you should make sure that the voltage is properly discharged.

Describe Impact Printers

Impact printers, such as the one shown in Figure 7-3, are basic. Impact printers have print heads that strike the inked ribbon, causing characters to be printed on the paper. Daisy-wheel and dot-matrix are examples of impact printers.

Figure 7-3 Impact Printer



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In a daisy-wheel printer, the wheel contains the letters, numbers, and special characters. The wheel rotates until the required character is in place, and an electromechanical hammer pushes the character into the ink ribbon. The character then strikes the paper, printing the character on the paper.

A dot-matrix printer is similar to the daisy-wheel printer, except that instead of a wheel containing characters, a print head contains pins that are surrounded by electromagnets. When energized, the pins push forward onto the ink ribbon, creating a character on the paper.

The number of pins on a print head, 9 or 24, indicates the quality of the print. The highest quality of print that is produced by a dot-matrix printer is called near-letter quality (NLQ).

Table 7-1 lists some advantages and disadvantages of an impact printer.

Table 7-1 Impact Printer Pros and Cons

Advantages	Disadvantages
Uses inexpensive consumables	Noisy
Uses continuous-feed paper	Low-resolution graphics
Has carbon copy printing capability	Limited color capability
	Slow printing, normally in the range of 32 to 76 characters per second (cps)

Describe Inkjet Printers

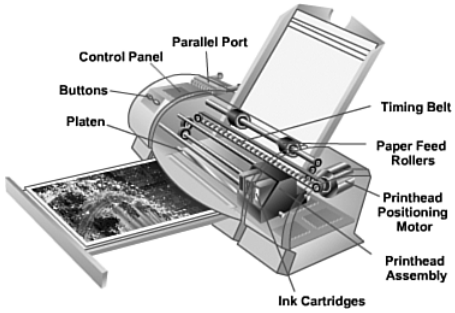
Inkjet printers produce high-quality prints. Inkjet printers are easy to use and inexpensive compared to laser printers. The print quality of an inkjet printer is measured in dots per inch (dpi). Higher dpi numbers provide greater image details. Figure 7-4 shows an all-in-one device that contains an inkjet printer. Figure 7-5 shows inkjet printer components.

Figure 7-4 Inkjet Printer



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Figure 7-5 Inkjet Printer Components



Inkjet printers use ink-filled cartridges that spray ink onto a page through tiny holes called nozzles. The ink is sprayed in a pattern on the page.

There are two types of inkjet nozzles:

- ***Thermal*:** A pulse of electrical current is applied to heating chambers around the nozzles. The heat creates a bubble of steam in the chamber. The steam forces ink out through the nozzle and onto the paper.
- ***Piezoelectric*:** Piezoelectric crystals are located in the ink reservoir at the back of each nozzle. A charge is applied to the crystal, causing it to vibrate. This vibration of the crystal controls the flow of ink onto the paper.

Inkjet printers use plain paper to make economical prints. Special-purpose paper may be used to create high-quality prints of photographs. When the inkjet print is complete and the paper leaves the printer, the ink is often wet. You should avoid touching printouts for 10 to 15 seconds to prevent the images from smearing.

Table 7-2 lists some advantages and disadvantages of an inkjet printer.

Table 7-2 Inkjet Printer Pros and Cons

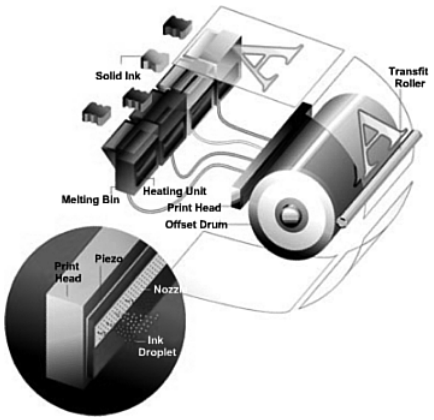
Advantages	Disadvantages
Low cost	Nozzles are prone to clogging
High resolution	Ink cartridges are expensive
Quick to warm up	Ink is wet after printing

Describe Solid-Ink Printers

Solid-ink printers use solid sticks of ink rather than toner or ink cartridges, as shown in Figure 7-6. Solid-ink printers produce high-quality images. The ink sticks are nontoxic and can be handled safely.

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Figure 7-6 Solid-Ink Printer



Solid-ink printers melt ink sticks and spray the ink through nozzles. The ink is sprayed onto a drum. The drum transfers the ink to paper.

Table 7-3 lists some advantages and disadvantages of a solid-ink printer.

Table 7-3 Solid-Ink Printer Pros and Cons

Advantages	Disadvantages
Produces vibrant color prints	Printers are expensive
Easy to use	Ink is expensive
Can use many different paper types	Printers are slow to warm up

Describe Other Printer Types

Two other printing technologies that you may work with are thermal and dye sublimation, as described in the following sections.

Thermal Printers

Some retail cash registers or older fax machines may contain ***thermal printers***, as shown in Figure 7-7. The paper used in thermal printers is chemically treated and has a waxy quality. Thermal paper becomes black when heated. Most thermal printer print heads are the width of the paper. Areas of the print head are heated as required to make the pattern on the paper. The paper is supplied in the form of a roll.

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Figure 7-7 Thermal Printer

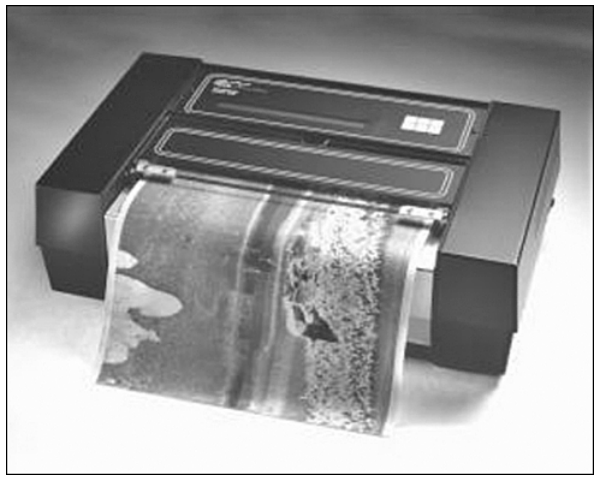


Table 7-4 lists some advantages and disadvantages of a thermal printer.

Table 7-4 Thermal Printer Pros and Cons

Advantages	Disadvantages
Longer life because there are few moving parts	Paper is expensive
	Paper has a short shelf life
	Images are poor quality
	Paper must be stored at room temperature

Dye-Sublimation Printers

Dye-sublimation printers, such as the one shown in Figure 7-8, produce photo-quality images for graphic printing. Dye-sublimation printers use solid sheets of ink that change directly from solid to gas in a process called *sublimating*. The print head passes over a sheet of cyan, magenta, yellow, and a clear overcoat (CMYO). There is a pass for each color. In photography, both dye-sublimation printers and small color inkjet printers provide quality prints.

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Figure 7-8 Dye-Sublimation Printer



Table 7-5 lists some advantages and disadvantages of a dye-sublimation printer.

Table 7-5 Dye-Sublimation Printer Pros and Cons

Advantages	Disadvantages
Printers produce high-quality images	Media can be expensive
Overcoat layer reduces smearing and increases moisture resistance	Printers are better for color than for grayscale (black and white)

Describe the Installation and Configuration Process for Printers

When you purchase a printer, the installation and configuration information is usually supplied by the manufacturer. An installation CD that includes drivers, manuals, and diagnostic software is included with the printer. The same tools may also be available as downloads from the manufacturer's website. Figure 7-9 show an example of what typically comes with a printer.

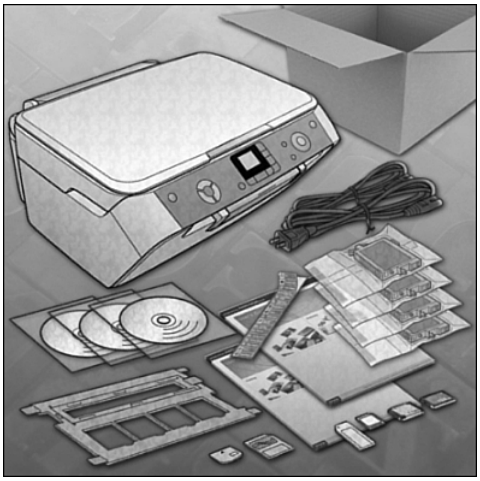
After completing this section, you will meet these objectives:

- Describe how to set up a printer.
- Explain how to power and connect the device using a local or network port.
- Describe how to install and update the device driver, firmware, and RAM.
- Identify configuration options and default settings.

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- Describe how to optimize printer performance.
- Describe how to print a test page.
- Describe how to share a printer.

Figure 7-9 Printer Package Contents



Describe How to Set Up a Printer

Although all types of printers are somewhat different to connect and configure, some procedures should be applied to all printers. After the printer has been unpacked and placed in position, connect it to the computer, network, or print server, and plug it into an electrical outlet.

Follow these steps to set up a printer:

How To

Step 1. Check the box to ensure that all required cables are provided.

Step 2. Remove all packing materials from the printer.

Step 3. Remove all plastic inserts from the consumables.

Step 4. Ensure that the printer location will not cause overheating.

Step 5. Install paper trays.

Step 6. Install paper.

Step 7. Read and follow the instruction manual.

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Explain How to Power and Connect the Device Using a Local or Network Port

Now that the printer has been unpacked and placed in position, you must connect it to the computer, network, or print server and plug it into an electrical outlet by following these steps:

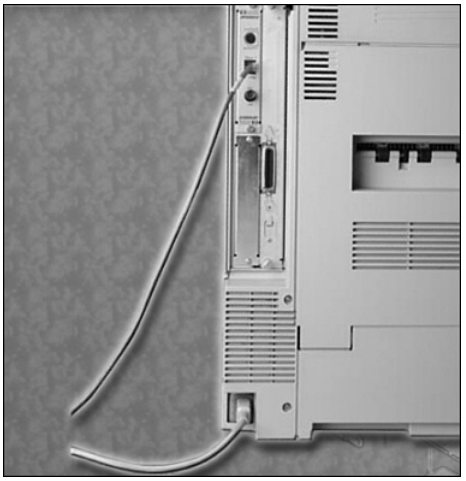
How To

Step 1. Connect the appropriate data cable to the communication port on the back of the printer. If the printer has a USB, FireWire, or parallel port, connect the corresponding cable to the printer port.

Step 2. Connect the other end of the data cable to the corresponding port on the back of the computer. If you are installing a network printer, connect the network cable to the network port.

Step 3. After the data cable has been properly connected, attach the power cable to the printer, as shown in Figure 7-10.

Figure 7-10 Connecting the Data and Power Cables on a Printer



Step 4. Connect the other end of the power cable to an available electrical outlet.

Caution

Never plug a printer into a UPS. The power surge that occurs when the printer is turned on will damage the UPS unit.

Describe How to Install and Update the Device Driver, Firmware, and RAM

After you have connected the power and data cables to the printer, the operating system may discover the printer and attempt to install a driver. If you have a driver disc from the

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manufacturer, use this driver. The driver that is included with the printer is usually more current than the drivers used by the operating system. Figure 7-11 shows the Add Printer wizard, which can also be used to install the new printer.

Figure 7-11 Printer Wizard Screen



Printer Drivers

Printer drivers are software programs that enable the computer and the printer to communicate with each other. Drivers also provide an interface for the user to configure printer options. Every printer model has a unique driver. Printer manufacturers frequently update drivers to increase the printer's performance, to add options, or to fix problems. You can download new printer drivers from the manufacturer's website. To update and test a printer driver, follow these steps:

How To

Step 1. **Find out if a newer driver is available.** Go to the printer manufacturer's website. Most manufacturer websites have a link from the main page to a page that offers drivers and support. Make sure that the driver is compatible with the computer that you are updating.

Step 2. **Download the driver.** Download the printer driver files to your computer. Most driver files come in a compressed or "zipped" format. Download the file to a folder, and uncompress or "unzip" the contents. Save instructions or documentation to a separate folder on your computer.

Step 3. **Install the downloaded driver.** Install the downloaded driver automatically or manually. Most printer drivers have a setup file that automatically searches the system for older drivers and replaces them with the new one. If no setup file is available, follow the directions supplied by the manufacturer.

Step 4. **Test the new printer driver.** Run multiple tests to make sure that the printer works properly. Use a variety of applications to print different types of documents. Change and test each printer option.

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Firmware

Firmware is a set of instructions stored on the printer. The firmware controls how the printer operates. Figure 7-12 shows a firmware upgrade utility. The procedure to upgrade firmware is very similar to the procedure for installing printer drivers.

Figure 7-12 Printer Firmware



Printer Memory

Adding printer memory to a printer can improve printing speed and allow the printer to handle more complex print jobs. All printers have at least some memory. Generally, the more memory a printer has, the more efficiently it operates. Here is a generic list of steps to follow to upgrade printer memory:

How To

Step 1. Turn off the printer.

Step 2. Disconnect all cables.

Step 3. Open the memory compartment.

Step 4. Replace memory modules or add new modules.

Step 5. Close the memory compartment.

Step 6. Reconnect all cables.

Step 7. Power on the printer.

Step 8. Run a self-test.

Step 9. Print a test page.

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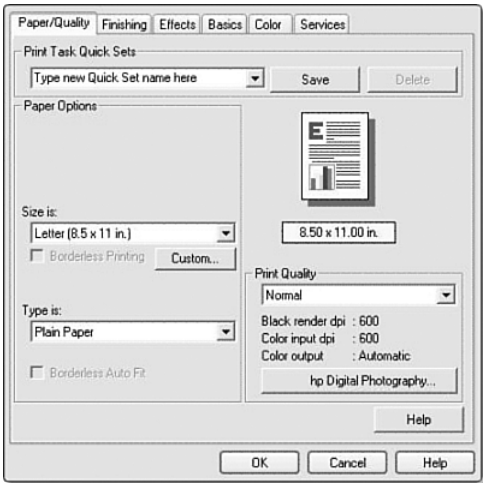
Consult the printer documentation for memory requirements:

- **Memory specifications:** Some printer manufacturers use standard types of memory, and other manufacturers use proprietary memory. Check the documentation for the type of memory, the speed of the memory, and the capacity of memory.
- **Memory population and availability:** Some printers have multiple memory slots. To find out how many memory slots are used and how many are available, you may need to open a compartment on the printer to check memory population.

Identify Configuration Options and Default Settings

Each printer may have different configurations and default options, as shown in Figure 7-13. Check the printer documentation for information about configurations and default settings.

Figure 7-13 Printer Settings



Here are some common configurations that are available for printers:

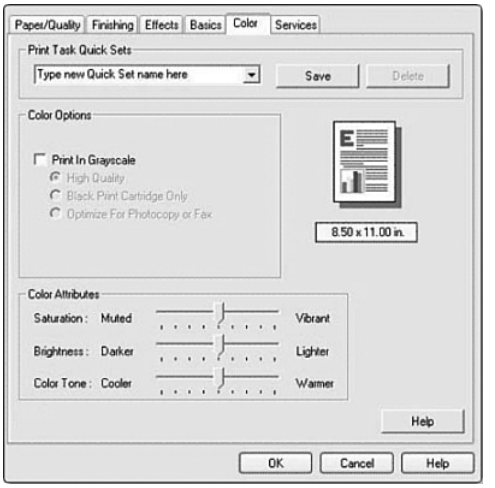
- **Paper type:** Standard, draft, gloss, or photo
- **Print quality:** Draft, normal, photo, or automatic
- **Color printing:** Multiple colors are used
- **Black-and-white printing:** Only black ink is used
- **Grayscale printing:** A color image is printed using only black ink in different shades
- **Paper size:** Standard paper sizes or envelopes and business cards
- **Paper orientation:** Landscape or portrait
- **Print layout:** Normal, banner, booklet, or poster
- **Duplex:** Normal or two-sided printing

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Describe How to Optimize Printer Performance

With printers, most optimization is completed through the software supplied with the drivers, as shown in Figure 7-14.

Figure 7-14 Color Calibration



The software has tools to optimize performance:

- **Print spool settings** let you cancel or pause current print jobs in the printer queue.
- **Color calibration** lets you adjust settings to match the colors on the screen to the colors on the printed sheet.
- **Paper orientation** lets you select landscape or portrait image layout.

Describe How to Print a Test Page

After installing a printer, you should print a test page to verify that the printer is operating properly. The test page confirms that the driver software is installed and working correctly and that the printer and computer are communicating.

Printing a Test Page

To print a test page manually, choose Start > Printers and Faxes to display the Printers and Faxes menu.

Right-click the desired printer and choose **Properties**. Click the **General** tab and click **Print Test Page**, as shown in Figure 7-15.

A dialog box opens, asking you if the page printed correctly. If the page did not print, built-in help files will assist you in troubleshooting the problem.

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Figure 7-15 Print Test Page



Printing from an Application

You can also test a printer by printing a test page from an application such as Notepad or WordPad. To access Notepad, choose **Start > Programs > Accessories > Notepad**.

A blank document opens. Enter some text in the document, and then print it by choosing **File > Print**.

Testing a Printer

You can also print from the command line to test the printer. Printing from the command line is limited to ASCII files, such as .txt and .bat files. To send a file to the printer from the command line, choose **Start > Run.** The Run box appears. Enter **cmd** in the Run box, and then click **OK**. At the command-line prompt, enter the command **print** *thefile***.txt**.

Testing the Printer from the Printer Panel

Most printers have a front panel with controls to allow you to generate test pages. This method of printing enables you to verify the printer operation separately from the network or computer. Consult the printer manufacturer's website or documentation to learn how to print a test page from the printer's front panel.

Describe How to Share a Printer

Printer sharing enables multiple users or clients to access a printer that they are not directly connected to. Figure 7-16 shows several computers with different operating systems, all connected to the same shared printer. This arrangement reduces the expense on a network, because fewer printers are required.

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Figure 7-16 Network Printer



Setting up printer sharing is simple with Windows XP. The following steps enable a computer to share a printer:

How To

Step 1. Choose **Start** > **Printers and Faxes**.

Step 2. Right-click the printer, and choose **Properties**.

Step 3. Click the **Sharing** tab.

Step 4. Click the **Share this printer** radio button, as shown in Figure 7-17.

Figure 7-17 Printer Sharing



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Step 5. Keep or change the share name.

Step 6. Click **Apply**.

All the computers that use the shared printer must have the correct drivers installed. Drivers for other operating systems can be installed on the print server.

To connect to the printer from another computer on the network, choose **Start > Printers and Faxes > Add Printer**. The Add Printer Wizard appears. Follow the steps using the wizard.

Describe the Types of Scanners Currently Available

As a computer technician, you may be required to purchase, repair, or maintain a scanner. The customer may ask you to perform the following tasks:

- Select a scanner.
- Install and configure a scanner.
- Troubleshoot a scanner.

After completing this section, you will meet the following objectives:

- Describe scanner types, resolution, and interfaces.
- Describe all-in-one devices.
- Describe flatbed scanners.
- Describe handheld scanners.
- Describe drum scanners.
- Compare costs of different types of scanners.

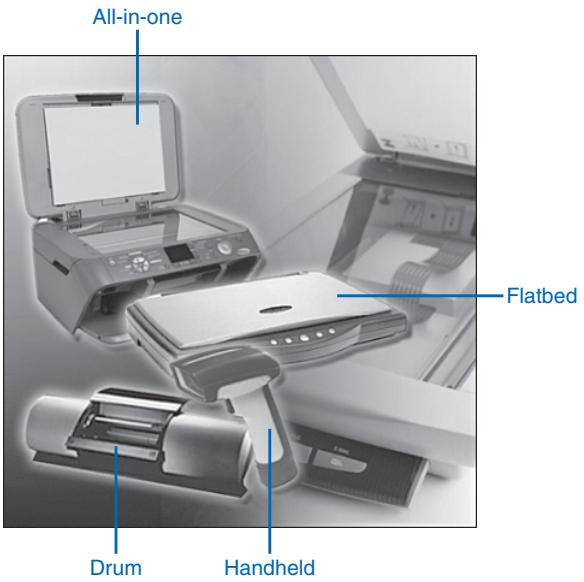
Describe Scanner Types, Resolution, and Interfaces

Scanners are used to convert printed data or images into an electronic data format that a computer can store or process as required. After an image has been scanned, it can be saved, modified, and even e-mailed, as you would with any other file. Although most scanners perform the same operation, different types of scanners are available, as shown in Figure 7-18 and described in the following list:

- ***All-in-one*:** Combination device that can scan, print, send faxes, and make copies
- ***Flatbed*:** Single-purpose device that converts hard-copy data to an electronic image
- ***Drum*:** High-quality scanner that spins film around a drum while a fixed laser or other beam of light captures the image as it spins
- ***Handheld*:** Portable scanner that is small enough to drag over text in books or other materials

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Figure 7-18 Types of Scanners



As with printers, the features, quality, and speed of the different types of scanners vary. Scanners typically create an RGB image that can be converted into common image formats such as JPEG, TIFF, BMP, and PNG. An RGB image has three channels: red, green, and blue. RGB channels generally follow the color receptors of the human eye and are used in computer displays and image scanners.

Some scanners can create text documents using ***optical character recognition (OCR)*** software. OCR software is used to convert a scanned printed page into text that can be edited with a word processor. A scanner's resolution is measured in dots per inch (dpi). As with printers, the higher the dpi, the better the image quality.

To allow communication of data, the scanner and computer must have compatible interfaces. The interfaces and cables used for printers typically are the same as the interfaces and cables used for scanners, as shown in Figure 7-19.

Describe All-in-One Devices

An all-in-one device combines the functionality of multiple devices into one physical piece of hardware. The devices may include media card readers and hard drives for storage. All-in-one devices generally include these functions:

- Scanner
- Printer
- Copier
- Fax

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Figure 7-19 Scanner Interfaces and Cables



All-in-one devices typically are used in home-office environments or where space is limited. These devices often are used with a computer but can operate alone to copy and fax documents.

Table 7-6 lists some advantages and disadvantages of an all-in-one device.

Table 7-6 All-in-One Device Pros and Cons

Advantages	Disadvantages
All devices are built in: scanner, fax, and printer	Not modular: if one device breaks, not all devices may be operational
Low cost	Not designed for heavy use
Upgrades are easier: software is designed for all devices	
Connection and setup are easy: one port	

Describe Flatbed Scanners

Flatbed scanners, shown in Figure 7-20, are often used to scan books and photographs for archiving. An electronic image is acquired by placing the book or photograph facedown on the glass. The scanner head, consisting of an array of image sensors, lies beneath the glass and moves along the item, capturing the image.

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Figure 7-20 Flatbed Scanner



Sheet feeders can be used with flatbed scanners to scan multiple images. A sheet feeder is a device that can be attached to some flatbed scanners to hold multiple sheets and feed them into the scanner one at a time. This feature allows for faster scanning; however, the image quality is usually not as good as a flatbed scanner that does not use a sheet feeder.

Table 7-7 lists some advantages and disadvantages of flatbed scanners.

Table 7-7 Flatbed Scanner Pros and Cons

Advantages	Disadvantages
Most common type of desktop scanner	Limited scanning size based on size of scanning bed
Low cost	
Connection and setup are easy: one port	

Describe Handheld Scanners

A handheld scanner, as shown in Figure 7-21, is small and portable. It is difficult to smoothly scan an image using a handheld scanner. To scan an item, carefully pass the scanner head across the item that you want to scan. As with a flatbed scanner, digital images are made from the images collected by the handheld scanner.

Figure 7-21 Handheld Scanner



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When you want to scan an item larger than the head of the handheld scanner, you must make more than one pass to capture the full image. It may be difficult to re-create the original image digitally when it is scanned in more than one pass. The images must be put back together to form a single image of the item that was scanned.

Table 7-8 lists some advantages and disadvantages of handheld scanners.

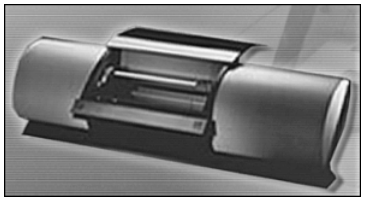
Table 7-8 Handheld Scanner Pros and Cons

Advantages	Disadvantages
Small	Multiple passes may need to be made to scan large items
Portable	Consistent image results vary, depending on the user experience
Can scan images that cannot fit in or on any other type of scanner	

Describe Drum Scanners

Drum scanners, as shown in Figure 7-22, produce a high-quality transfer of an image. Drum scanners are usually used commercially but are being replaced by lower-priced, high-quality flatbed scanners. Many drum scanners are still in use for high-end reproductions, such as archiving photographs in museums.

Figure 7-22 Drum Scanner



To scan an image using a drum scanner, you attach the image to a revolving drum or load it into a supporting canister. The drum is rotated at high speed across optical scanners. The optical scanners move slowly across the drum surface until the entire image is captured. The captured image is then reproduced by the computer as a digital image file.

Table 7-9 lists some advantages and disadvantages of drum scanners.

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Table 7-9 Drum Scanner Pros and Cons

Advantages	Disadvantages
High-end image results	Expensive
	Difficult to operate

Describe the Installation and Configuration Process for Scanners

When you purchase a scanner, the installation and configuration information is usually supplied by the manufacturer. An installation CD that includes drivers, manuals, and diagnostic software is included with the scanner. The same tools may also be available as downloads from the manufacturer's website.

After completing this section, you will meet the following objectives:

- Explain how to power and connect a scanner.
- Describe how to install and update the device driver.
- Identify configuration options and default settings.

Explain How to Power and Connect a Scanner

Like printers, scanners can connect to a computer using the USB, FireWire, network, or parallel port interface. Some scanners may connect using a SCSI interface.

Scanners that are built into an all-in-one device should be plugged directly into an AC wall outlet. This provides the AC current necessary to operate the all-in-one device. Other types of scanners may acquire power through the USB or FireWire connector.

After unpacking the scanner, connect the appropriate power and data cables. Use the scanner documentation as your guide, or check the manufacturer's website for instructions.

Describe How to Install and Update the Device Driver

As soon as you have connected and started the scanner, the computer operating system might be able to discover the scanner through the plug-and-play process. If the scanner is discovered, the operating system might automatically install a driver.

After you set up a scanner, install the driver software that the manufacturer includes with the scanner. This driver is usually more current than the drivers on your computer. It may also provide more functionality than the basic driver from Windows.

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As with a printer, you might want to install drivers from the manufacturer's website to gain additional functionality, diagnostic tools, and troubleshooting utilities. Download software from the manufacturer's website, and follow any directions provided to install the software and utilities for your scanner. Some scanning software automatically downloads and installs updated software, drivers, or firmware. Follow the directions provided by the update utility to install these files.



Lab 7.4.2: Install All-in-One Device and Software

In this lab you install an all-in-one device. You find, download, and update the driver and the software for the all-in-one device. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Identify Configuration Options and Default Settings

Scanners have configuration options and default settings that differ between model types and manufacturers.

A scanner might come with a basic graphic editing software package for editing photographs and other images. Editing software packages may include OCR software that allows text in a scanned image to be manipulated.

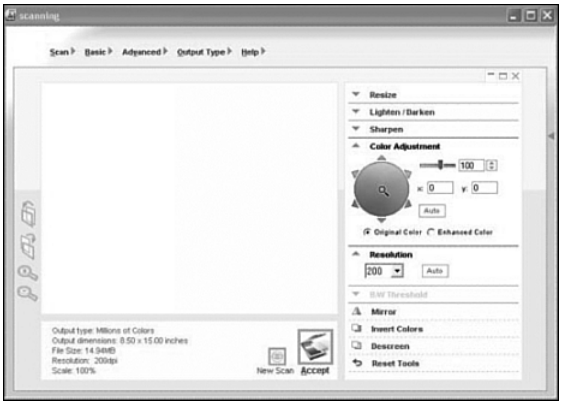
Some of the configuration options that might be available on a scanner are as follows:

- Color, grayscale, or black-and-white scanning
- One-touch scanning into your choice of software
- Quality and resolution choices
- Sheet feeders

As shown in Figure 7-23, color calibration between devices is important so that you see true representations of color. To calibrate a scanner, scan a graphic that contains specific colors. A calibration application installed on the computer compares the scanner's output against the known colors of the sample graphic on the display. The software adjusts the scanner's color accordingly. When your scanner, monitor, and printer treat the same colors in the same way, the image you print matches the image you scan.

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Figure 7-23 Scanner Calibration



Identify and Apply Common Preventive Maintenance Techniques for Printers and Scanners

Printers and scanners have many moving parts that can wear out over time or through extended use. They must be maintained regularly to operate correctly.

Moving parts can be affected by dust and other air particles. Clean printers and scanners regularly to avoid downtime, loss of productivity, and high repair costs.

After completing this section, you will meet the following objectives:

- Describe printer maintenance.
- Describe scanner maintenance.

Describe Printer Maintenance

Printers have many moving parts and require a higher level of maintenance than most other electronic devices. Impurities produced by the printer collect on the internal components. Over time, if the impurities are not removed, the printer may malfunction. The maintenance schedule for a printer can be found in the manual or on the manufacturer's website.

Caution

Be sure to unplug the printer from the electrical source before beginning any type of maintenance.

Most printers come with printer monitoring and diagnostic software from the manufacturer that can help you maintain the printer. Observe the guidelines from the manufacturer for cleaning the following printer and scanner components:

- Printer roller surfaces
- Printer and scanner paper-handling mechanisms

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The type and quality of paper and ink used can affect the printer's life:

- **Paper selection:** High-quality paper can help ensure that the printer operates efficiently and for a long time. Many types of printer paper are available, including inkjet and laser. The printer manufacturer may recommend the type of paper that should be used for best results. Some papers, especially photo paper and transparencies, have a right side and a wrong side. Load the paper according to the manufacturer's instructions.
- **Ink selection:** The manufacturer recommends the brand and type of ink that you should use. If the wrong type of ink is installed, the printer may not work, or the print quality may be reduced. You should avoid refilling the ink cartridges, because the ink may leak.

Describe Scanner Maintenance

The scanner surface should be kept clean. If the glass becomes dirty, consult the manufacturer's user manual for cleaning recommendations. To prevent liquid from leaking into the scanner case, do not spray glass cleaner directly on the device. Dampen a cloth with the cleaner, and then apply the cleaner gently to the glass.

If the inside of the glass becomes dirty, check the manual for instructions on how to open the unit or remove the glass from the scanner. If possible, thoroughly clean both sides of the glass, and replace the glass as it was originally set in the scanner. When the scanner is not in use, keep the lid closed. Keep a handheld scanner in a safe place. Also, never lay anything heavy on a scanner, because you may damage the casing or internal parts.

Troubleshoot Printers and Scanners

With printer and scanner problems, a technician must be able to determine if the problem exists with the device, the cable connection, or the computer that it is attached to. Follow the steps outlined in this section to accurately identify, repair, and document the problem.



Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

After completing this section, you will meet these objectives:

- Review the troubleshooting process.
- Identify common problems and solutions.

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Review the Troubleshooting Process

Printer problems can result from a combination of hardware, software, and network issues. Computer technicians must be able to analyze the problem and determine the cause of the error to repair the printer. This process is called *troubleshooting*.

Step 1: Gather Data from the Customer

The first step in the troubleshooting process is to gather data from the customer. Ask the customer some open-ended and closed-ended questions.

Some examples of open-ended questions are as follows:

- What problems are you experiencing with your printer or scanner?
- What software or hardware has been installed on your computer recently?
- What were you doing when the problem was identified?
- What error messages have you received?
- What type of connection is the printer or scanner using?

Some examples of closed-ended questions are as follows:

- Is the printer/scanner under warranty?
- Is the printer/scanner making any strange noises?
- Have you updated the software that supports the printer/scanner?

Step 2: Verify the Obvious Issues

After talking to the customer, you should verify the obvious issues. Here is a list of some common issues for printers and scanners:

- Loose cable connections
- Paper jams
- Equipment power
- Low-ink warning
- Out of paper
- Errors on the equipment display
- Errors on the computer screen

Step 3: Try Quick Solutions First

After the obvious issues have been verified, try some quick solutions. Some quick solutions for printers and scanners include the following:

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- Restart the printer or scanner.
- Disconnect and reconnect the cables.
- Restart the computer.
- Check the printer for paper jams.
- Reseat the paper in the paper trays.
- Open and close the printer trays.
- Ensure that the printer doors are closed.

Step 4: Gather Data from the Computer

If quick solutions do not correct the problem, gather data from the computer. Here are some different ways to gather information about the problem from the computer:

- Check that the correct printer is set as the default printer.
- Check that the correct services are running.
- Check Device Manager for any hardware issues.
- Check that the printer is configured correctly.

Step 5: Evaluate the Problem and Implement the Solution

At this point, you have enough information to evaluate the problem and then research and implement possible solutions. Some resources for possible solutions include the following:

- A past problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

Step 6: Close with the Customer

After you have solved the printer or scanner problem, you close with the customer. Here is a list of the tasks required to complete this step:



Step 1. Discuss the solution implemented with the customer.

Step 2. Have the customer verify that the problem has been solved.

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Step 3. Provide the customer with all the paperwork.

Step 4. Document the steps taken to solve the problem in the work order and the technician's journal.

Step 5. Document any components used in the repair.

Step 6. Document the time spent resolving the problem.

Identify Common Problems and Solutions

Printer or scanner problems can be attributed to hardware, software, networks, or some combination of the three. You will resolve some types of printer and scanner problems more often than others. Table 7-10 is a chart of common printer and scanner problems and solutions.

Table 7-10 Common Printer and Scanner Problems and Solutions

Problem Symptom	Possible Solution
Printer does not print	Delete the print job from the queue, and print again.
Printer is printing unknown characters	Uninstall and reinstall the print driver.
Laser printer prints lines or streaks on every page	Replace the toner cartridge.
Scanner head doesn't move	Unlock the scanner head.
Computer doesn't detect the scanner	Make sure that all the cables are connected properly.
SCSI scanner does not scan	Make sure that the scanner is started before the computer.

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Summary

This chapter discussed various types of printers and scanners. You learned that there are many different types and sizes of printers and scanners, each with different capabilities, speeds, and uses. You also learned that both printers and scanners can be connected directly to computers, as well as shared across a network. This chapter also introduced the different types of cables and interfaces available to connect a printer or scanner. Other facts about printers and scanners covered in this chapter include the following:

- Some printers and scanners have low output and are adequate for home use, whereas other printers and scanners have high output and are designed for commercial use.
- Printers may have different speeds and quality of print.
- Older printers and scanners use parallel cables and ports. Newer printers and scanners typically use USB or FireWire cables and connectors.
- Larger printers and scanners may also have a NIC port to connect to a network.
- Newer printers and scanners are plug-and-play. The computer automatically installs the necessary drivers.
- If the computer does not automatically install the device drivers, you have to supply the drivers on a CD or download them from the manufacturer's website.
- Most optimization is done through software drivers and utilities.
- After you have set up the printer or scanner, you can share the device with other users on the network. This arrangement is cost-efficient because there is no need for every user to have a printer or scanner.
- A good preventive maintenance program will extend the life of printers and scanners and keep them performing well.
- Troubleshooting printer and laptop problems requires the technician to identify, repair, and document the problem. Troubleshooting steps include gathering data from customer, verifying the obvious issues, trying quick solutions first, gathering data from the computer, evaluating the problem, implementing the solution, and closing with the customer.

Summary of Exercises

This is a summary of the Labs, Worksheets, Remote Technician exercises, Class Discussions, Virtual Desktop activities, and Virtual Laptop activities associated with this chapter.



Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Lab 7.4.2: Install All-in-One Device and Software

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Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Which technology do dot-matrix printers use?

   A. Digital
   B. Drop electrostatic spray
   C. Electrophotographic
   D. Ink melting
   E. Impact

2. Which phase of the laser printing process includes applying toner to the latent image?

   A. Cleaning
   B. Conditioning
   C. Developing
   D. Fusing
   E. Transferring
   F. Writing

3. What are three disadvantages of impact printers?

   A. Expensive consumables
   B. High power consumption
   C. Limited color capability
   D. Noisy printing
   E. Slow printing
   F. Unable to use continuous-feed paper

4. Which type of printer melts ink and sprays it through a nozzle onto a drum to transfer an image onto paper?

   A. Fusion ink
   B. Impact
   C. Inkjet
   D. Laser
   E. Solid-ink
   F. Thermal

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5. Which type of printing process uses solid sheets of ink that change directly to gas when the print head heats the ink?

   A. Dye-sublimation
   B. Impact
   C. Inkjet
   D. Laser
   E. Solid-ink
   F. Thermal

6. Which peripheral is used to convert paper documents into electronic files?

   A. Digital reader
   B. Printer
   C. Projector
   D. Scanner

7. Refer to Figure 7-24. A customer purchases the scanner shown and discovers that it is limited to converting hard-copy data into electronic images. Which type of scanner has the customer purchased?

Figure 7-24 Figure for Question 7



   A. All-in-one
   B. Flatbed
   C. Handheld
   D. Laser

8. How is the speed of a laser printer measured?

   A. Dots per minute
   B. Pages per minute
   C. Pixels per second
   D. Pages per second
   E. Pages per week

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CHAPTER 8

Fundamental Networks

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- What are the principles of networking?
- What are the different types of networks?
- What are the basic networking concepts and technologies?
- What makes up the physical components of a network?
- What are the LAN topologies and architectures?
- What are some of the standards organizations?
- What are the Ethernet standards?
- What are the OSI and TCP/IP data models?
- How do I configure a NIC and a modem?
- What are the names, purposes, and characteristics of other technologies used to establish connectivity?
- How do I identify and apply common preventive maintenance techniques used with networks?
- How do I troubleshoot a network?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

networking *page xx*

local-area network (LAN) *page xx*

wide-area network (WAN) *page xx*

wireless LAN (WLAN) *page xx*

peer-to-peer network *page xx*

client/server network *page xx*

IP addressing *page xx*

protocol *page xx*

bandwidth *page xx*

bits per second (bps) *page xx*

kilobits per second (kbps) *page xx*

megabits per second (Mbps) *page xx*

simplex *page xx*

half duplex *page xx*

full duplex *page xx*

broadband *page xx*

digital subscriber line (DSL) *page xx*

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This chapter provides an overview of network principles, standards, and purposes. The following types of networks are discussed in this chapter:

- Local-area network (LAN)
- Wide-area network (WAN)
- Wireless LAN (WLAN)

This chapter discusses the different types of network topologies, protocols, and logical models as well as the hardware needed to create a network. Configuration, troubleshooting, and preventive maintenance also are covered. In addition, you will learn about network software, communication methods, and hardware relationships.

Explain the Principles of Networking

Networks are systems that are formed by links. Websites that allow individuals to link to each other's pages are called social networking sites. A set of related ideas can be called a conceptual network. The connections you have with all your friends can be called your personal network.

People use the following networks every day:

- Mail delivery system
- Telephone system
- Public transportation system
- Corporate computer network
- The Internet

Computers can be linked by networks to share data and resources. A network can be as simple as two computers connected by a single cable or as complex as hundreds of computers connected to devices that control the flow of information. Converged data networks can include general-purpose computers, such as PCs and servers, as well as devices with more specific functions, including printers, phones, televisions, and game consoles.

All data, voice, video, and converged networks share information and use various methods to direct how this information flows. The information on the network goes from one place to another, sometimes via different paths, to arrive at the appropriate destination.

The public transportation system is similar to a data network. The cars, trucks, and other vehicles are like the messages that travel within the network. Each driver defines a starting

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point (source) and an ending point (destination). Within this system are rules such as stop signs and traffic lights that control the flow from the source to the destination.

After completing this section, you will meet these objectives:

- Define computer networks.
- Explain the benefits of networking.

Define Computer Networks

A computer data network is a collection of hosts connected by ***networking*** devices. A host is any device that sends and receives information on the network. Peripherals are devices that are connected to hosts. Some devices can serve as either hosts or peripherals. For example, a printer connected to your laptop that is on a network is acting as a peripheral. If the printer is connected directly to a networking device, such as a hub, switch, or router, it is acting as a host.

Computer networks are used globally in businesses, homes, schools, and government agencies. Many of these networks are connected to each other through the Internet.

Many different types of devices can connect to a network:

- Desktop computers
- Laptop computers
- Printers
- Scanners
- PDAs
- Smartphones
- File/print servers

A network can share many different types of resources:

- Services, such as printing or scanning
- Storage space on removable devices, such as hard drives or optical drives
- Applications, such as databases

You can use networks to access information stored on other computers, print documents using shared printers, and synchronize the calendar between your computer and your Smartphone.

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Network devices are linked using a variety of connections:

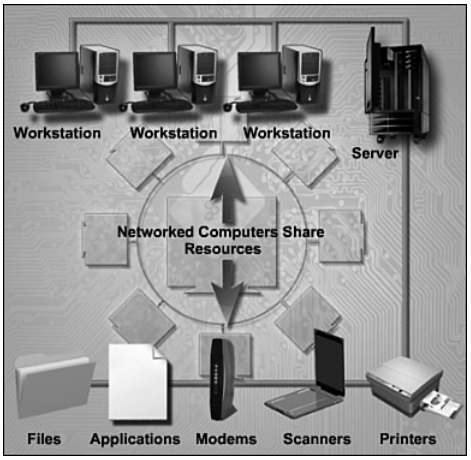
- **Copper cabling** uses electrical signals to transmit data between devices.
- **Fiber-optic cabling** uses glass or plastic wire, also called fiber, to carry information as light pulses.
- **Wireless connection** uses radio signals, infrared technology (laser), or satellite transmissions.

Explain the Benefits of Networking

The benefits of networking computers and other devices include lower costs and increased productivity. With networks, resources can be shared, which results in less duplication and corruption of data. The following are some benefits of using networks:

- Fewer peripherals are needed: Figure 8-1 shows that many devices can be connected on a network. Each computer on the network does not need its own printer, scanner, or backup device. Multiple printers can be set up in a central location and can be shared among the network users. All network users send print jobs to a central print server that manages the print requests. The print server can distribute print jobs over multiple printers or can queue jobs that require a specific printer.

Figure 8-1 Shared Resources



- Increased communication capabilities: Networks provide several different collaboration tools that can be used to communicate between network users. Online collaboration tools include e-mail, forums and chats, voice and video, and instant messaging. With these tools, users can communicate with friends, family, and colleagues.

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- Avoid file duplication and corruption: A server manages network resources. Servers store data and share it with users on a network. Confidential or sensitive data can be protected and shared with the users who have permission to access that data. Document-tracking software can be used to prevent users from overwriting files, or changing files that others are accessing at the same time.
- Lower-cost licensing: Application licensing can be expensive for individual computers. Many software vendors offer site licenses for networks, which can dramatically reduce the cost of software. The site license allows a group of people or an entire organization to use the application for a single fee.
- Centralized administration: Centralized administration reduces the number of people needed to manage the devices and data on the network, reducing time and cost to the company. Individual network users do not need to manage their own data and devices. One administrator can control the data, devices, and permissions of users on the network. Backing up data is easier because the data is stored in a central location.
- Conserve resources: Data processing can be distributed across many computers to prevent one computer from becoming overloaded with processing tasks.

Describe Types of Networks

Data networks continue to evolve in complexity, use, and design. Different types of networks have different descriptive names. A computer network is identified by the following specific characteristics:

- The area it serves
- How the data is stored
- How the resources are managed
- How the network is organized
- The type of networking devices used
- The type of media used to connect the devices

After completing this section, you will meet these objectives:

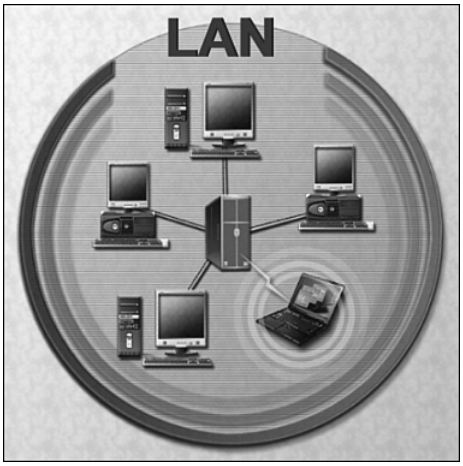
- Describe a LAN.
- Describe a WAN.
- Describe a WLAN.
- Explain peer-to-peer networks.
- Explain client/server networks.

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Describe a LAN

A local-area network (LAN) is a group of interconnected devices that is under the same administrative control, as shown in Figure 8-2. In the past, LANs were considered to be small networks that existed in a single physical location. Although LANs can be as small as a single local network installed in a home or small office, over time, the definition of LANs has evolved to include interconnected local networks consisting of many hundreds of devices, installed in multiple buildings and locations.

Figure 8-2 Local-Area Network



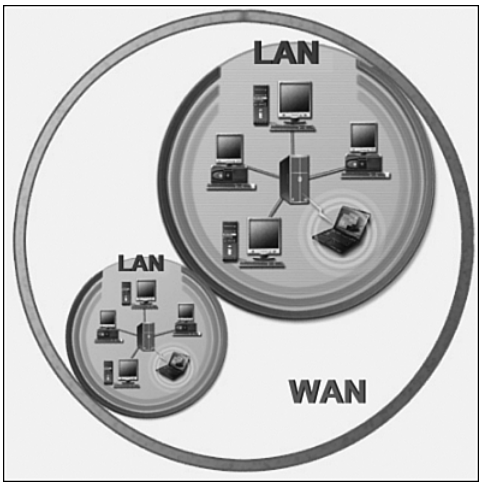
The important thing to remember is that all the local networks within a LAN are under one administrative control group that governs the security and access control policies that are in force on the network. In this context, the word “local” in local-area network refers to local consistent control rather than being physically close to each other. Devices in a LAN may be physically close, but this is not a requirement.

Describe a WAN

Wide-area networks (WAN) are networks that connect LANs in geographically separated locations, as shown in Figure 8-3. The most common example of a WAN is the Internet. The Internet is a large WAN that is composed of millions of interconnected LANs. Telecommunications service providers (TSP) are used to interconnect these LANs at different locations.

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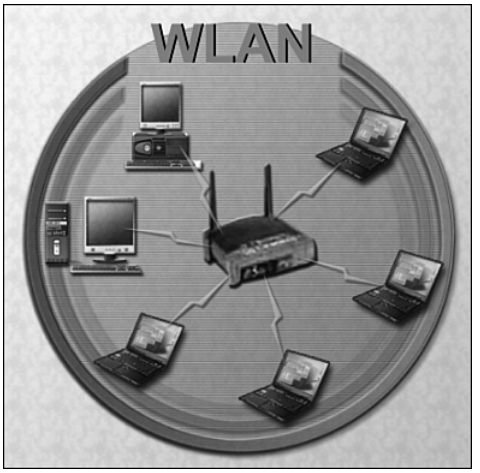
Figure 8-3 Wide-Area Network



Describe a WLAN

In a traditional LAN, devices are interconnected using copper cabling. In some environments, installing copper cabling may not be practical, desirable, or even possible. In these situations, wireless devices are used to transmit and receive data using radio waves. These networks are called ***wireless LANs (WLAN)***. Figure 8-4 shows a WLAN. As with LANs, on a WLAN you can share resources, such as files and printers, and access the Internet.

Figure 8-4 Wireless Local-Area Network



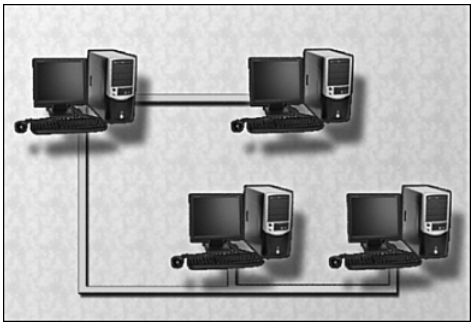
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In a WLAN, wireless devices connect to access points within a specified area. Access points typically are connected to the network using copper cabling. Instead of providing copper cabling to every network host, only the wireless access point is connected to the network with copper cabling. WLAN coverage can be small and limited to the area of a room or can have greater range.

Explain Peer-to-Peer Networks

In a ***peer-to-peer network***, devices are connected directly to each other without any additional networking devices between them, as shown in Figure 8-5. In this type of network, each device has equivalent capabilities and responsibilities. Individual users are responsible for their own resources and can decide which data and devices to share. Because individual users are responsible for the resources on their own computers, the network has no central point of control or administration.

Figure 8-5 Peer-to-Peer Network



Peer-to-peer networks work best in environments with ten or fewer computers. Because individual users are in control of their own computers, there is no need to hire a dedicated network administrator.

Peer-to-peer networks have several disadvantages:

- They have no centralized network administration, which makes it difficult to determine who controls resources on the network.
- They have no centralized security. Each computer must use separate security measures for data protection.
- The network becomes more complex and difficult to manage as the number of computers on the network increases.
- There may be no centralized data storage. Separate data backups must be maintained. This responsibility falls on the individual users.

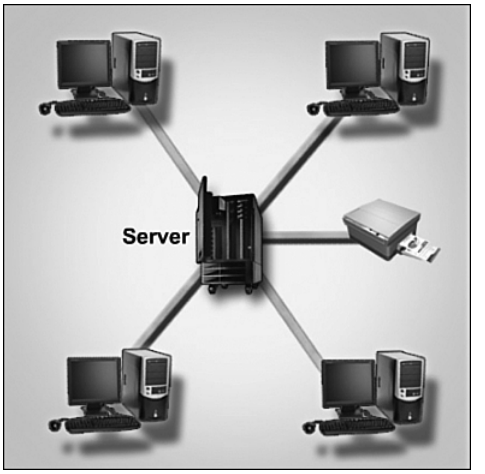
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Peer-to-peer networks still exist inside larger networks today. Even on a large client network, users can still share resources directly with other users without using a network server. In your home, if you have more than one computer, you can set up a peer-to-peer network. You can share files with other computers, send messages between them, and print documents to a shared printer.

Explain Client/Server Networks

In a ***client/server network***, shown in Figure 8-6, the client requests information or services from the server. The server provides the requested information or service to the client. Servers on a client/server network commonly perform some of the processing work for client machines, such as sorting through a database before delivering only the records requested by the client.

Figure 8-6 Client/Server Network



One example of a client/server network is a corporate environment in which employees use a company e-mail server to send, receive, and store e-mail. The e-mail client on an employee computer issues a request to the e-mail server for any unread e-mail. The server responds by sending the requested e-mail to the client.

In a client/server model, the servers are maintained by network administrators. Data backups and security measures are implemented by the network administrator. The network administrator also controls user access to the network resources. All the data on the network is stored on a centralized file server. Shared printers on the network are managed by a centralized print server. Network users with the proper permissions can access both the data and shared printers. Each user must provide an authorized username and password to gain access to network resources that he or she is permitted to use.

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For data protection, an administrator performs a routine backup of all the files on the servers. If a computer crashes, or data is lost, the administrator can easily recover the data from a recent backup.

Describe Basic Networking Concepts and Technologies

As a computer technician, you will be required to configure and troubleshoot computers on a network. To effectively configure a computer on the network, you should understand ***IP addressing***, ***protocols***, and other network concepts.

After completing this section, you will meet these objectives:

- Explain bandwidth and data transmission.
- Describe IP addressing.
- Define DHCP.
- Describe Internet protocols and applications.
- Define ICMP.

Explain Bandwidth and Data Transmission

Bandwidth is the amount of data that can be transmitted within a fixed time period. When data is sent over a computer network, it is broken into small chunks called packets. Each packet contains headers. A header is information added to each packet that contains the packet's source and destination. A header also contains information that describes how to put all the packets back together again at the destination. The size of the bandwidth determines the amount of information that can be transmitted.

Bandwidth is measured in bits per second and usually is denoted by any of the following units of measure:

- ***bps*** is bits per second.
- ***kbps*** is kilobits per second.
- ***Mbps*** is megabits per second.

Note

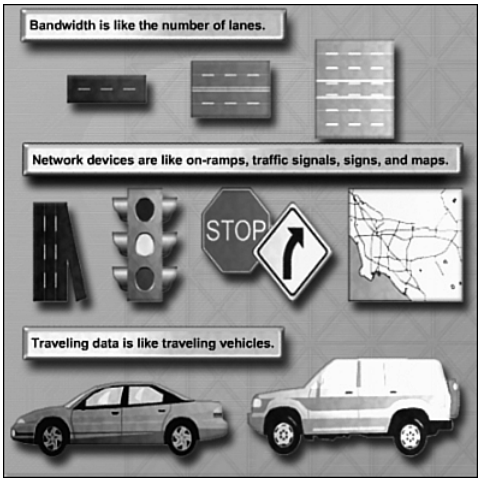
1 byte is equal to 8 bits and is abbreviated with a capital B. 1 MBps is approximately 8 Mbps.

Figure 8-7 shows how bandwidth on a network can be compared to a highway. In this example, the cars and trucks represent the data. The number of lanes on the highway

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represents the number of cars that can travel on the highway at the same time. An eight-lane highway can handle four times the number of cars that a two-lane highway can.

Figure 8-7 Highway Analogy



The data that is transmitted over the network can flow using one of three modes: simplex, half duplex, or full duplex:

- ***Simplex*:** Simplex, also called unidirectional, is a single one-way transmission. An example of simplex transmission is the signal that is sent from a TV station to your TV.
- ***Half duplex*:** When data flows in one direction at a time, this is known as half duplex. With half duplex, the communications channel allows alternating transmission in two directions, but not in both directions simultaneously. Two-way radios, such as police and emergency communications mobile radios, work with half-duplex transmissions. When you press the button on the microphone to transmit, you cannot hear the person on the other end. If people at both ends try to talk at the same time, neither transmission gets through.
- ***Full duplex*:** When data flows in both directions at the same time, this is known as full duplex. Although the data flows in both directions, the bandwidth is measured in only one direction. A network cable with 100 Mbps in full-duplex mode has a bandwidth of 100 Mbps. A telephone conversation is an example of full-duplex communication. Both people can talk and be heard at the same time.

Full-duplex networking technology increases network performance because data can be sent and received at the same time. Broadband technology allows multiple signals to travel on the same wire simultaneously. ***Broadband*** technologies, such as ***digital subscriber line (DSL)*** and cable, operate in full-duplex mode. With a DSL connection, for example, users can download data to their computer and talk on the telephone at the same time.

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Describe IP Addressing

An ***IP address*** is a number that is used to identify a device on the network. Each device on a network must have a unique IP address to communicate with other network devices. As noted earlier, a host is a device that sends or receives information on the network. Network devices are devices that move data across the network, including hubs, switches, and routers. On a LAN, each host and network device must have an IP address within the same network to be able to communicate with each other.

A person's name and fingerprints usually do not change. They provide a label or address for the person's physical aspect—the body. A person's mailing address, on the other hand, relates to where the person lives or picks up mail. This address can change. On a host, the Media Access Control (MAC) address (explained in the section "Manual Configuration") is assigned to the host NIC and is known as the physical address. The physical address remains the same regardless of where the host is placed on the network in the same way that fingerprints remain with someone regardless of where she goes.

The IP address is similar to someone's mailing address. It is known as a logical address because it is logically assigned based on the host location. The IP address, or network address, is based on the local network and is assigned to each host by a network administrator. This process is similar to the local government assigning a street address based on the logical description of the city or village and neighborhood.

An IP address consists of a series of 32 binary bits (1s and 0s). It is very difficult for humans to read a binary IP address. For this reason, the 32 bits are grouped into four 8-bit bytes called octets. An IP address, even in this grouped format, is hard for humans to read, write, and remember. Therefore, each octet is presented as its decimal value, separated by a decimal point or period. This format is called dotted-decimal notation. When a host is configured with an IP address, it is entered as a dotted-decimal number, such as 192.168.1.5. Imagine if you had to enter the 32-bit binary equivalent of this: 11000000101010000000000100000101. If you mistyped just 1 bit, the address would be different, and the host may not be able to communicate on the network.

The logical 32-bit IP address is hierarchical and is composed of two parts. The first part identifies the network, and the second part identifies a host on that network. Both parts are required in an IP address. For example, if a host has an IP address of 192.168.18.57, the first three octets, 192.168.18, identify the network portion of the address, and the last octet, 57, identifies the host. This is called hierarchical addressing, because the network portion indicates the network on which each unique host address is located. Routers only need to know how to reach each network, not the location of each individual host.

IP addresses are divided into the following five classes:

- **Class A** is for large networks, implemented by large companies and some countries.
- **Class B** is for medium-sized networks, implemented by universities.

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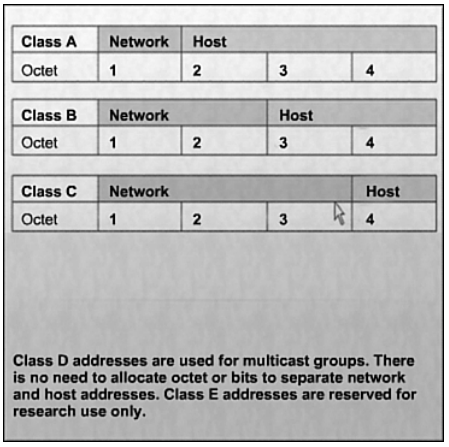
- **Class C** is for small networks, implemented by ISPs for customer subscriptions.
- **Class D** is for special use for multicasting.
- **Class E** is used for experimental testing.

Subnet Mask

The ***subnet mask*** indicates the network portion of an IP address. Like the IP address, the subnet mask is a dotted-decimal number. Usually all hosts within a LAN use the same subnet mask. Figure 8-8 shows default subnet masks for usable IP addresses that are mapped to the first three classes of IP addresses:

- **255.0.0.0:** Class A, which indicates that the first octet of the IP address is the network portion
- **255.255.0.0:** Class B, which indicates that the first two octets of the IP address are the network portion
- **255.255.255.0:** Class C, which indicates that the first three octets of the IP address are the network portion

Figure 8-8 IP Address Classes



If an organization owns one Class B network but needs to provide IP addresses for four LANs, the organization would have to subdivide the Class B address into four smaller parts. Subnetting is a logical division of a network. It provides the means to divide a network, and the subnet mask specifies how it is subdivided. An experienced network administrator typically performs subnetting. After the subnetting scheme has been created, the proper IP addresses and subnet masks can be configured on the hosts in the four LANs. These skills are taught in the Cisco Networking Academy courses related to CCNA-level networking skills.

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Manual Configuration

In a network with a small number of hosts, it is easy to manually configure each device with the proper IP address. A network administrator who understands IP addressing should assign the addresses and should know how to choose a valid address for a particular network. The IP address that is entered is unique for each host within the same network or subnet.

To manually enter an IP address on a host, go to the TCP/IP settings in the Properties window for the Network Interface Card (NIC). The NIC is the hardware that enables a computer to connect to a network. It has an address called the MAC address. Whereas the IP address is a logical address that is defined by the network administrator, a MAC address is "burned in," or permanently programmed into the NIC when it is manufactured. The IP address of a NIC can be changed, but the MAC address never changes.

The main difference between an IP address and a MAC address is that the MAC address is used to deliver frames on the LAN, while an IP address is used to transport frames outside the LAN. A frame is a data packet, along with address information added to the beginning and end of the packet before transmission over the network. After a frame is delivered to the destination LAN, the MAC address is used to deliver the frame to the end host on that LAN.

If more than a few computers comprise the LAN, manually configuring IP addresses for every host on the network can be time-consuming and prone to errors. In this case, using a Dynamic Host Configuration Protocol (DHCP) server would automatically assign IP addresses and greatly simplify the addressing process.



Worksheet 8.3.2: Identify IP Address Classes

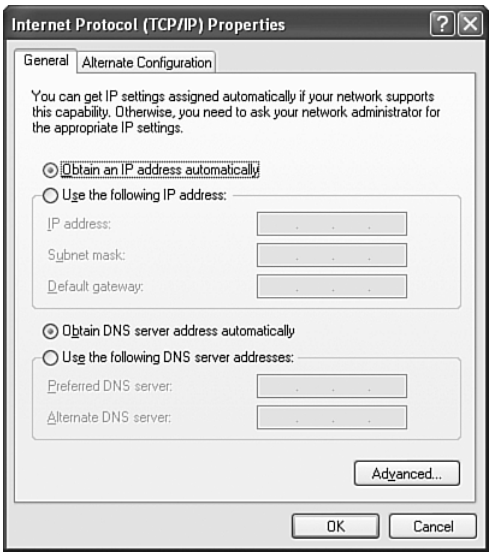
In this worksheet you identify the IP address class for an IP address. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this worksheet now or wait until the end of the chapter.

Define DHCP

Dynamic Host Configuration Protocol (DHCP) is a software utility used to dynamically assign IP addresses to network devices. This dynamic process eliminates the need to manually assign IP addresses. A DHCP server can be set up and the hosts can be configured to automatically obtain an IP address. When a computer is set to obtain an IP address automatically, all the other IP addressing configuration boxes are dimmed, as shown in Figure 8-9. The server maintains a list of IP addresses to assign, and it manages the process so that every device on the network receives a unique IP address. Each address is held for a predetermined amount of time. When the time expires, the DHCP server can use this address for any computer that joins the network.

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Figure 8-9 TCP/IP Properties



This is the IP address information that a DHCP server can assign to hosts:

- IP address
- Subnet mask
- Default gateway
- Optional values, such as a ***Domain Name System (DNS) server*** address

The DHCP server receives a request from a host. The server then selects IP address information from a set of predefined addresses that are stored in a database. After the IP address information is selected, the DHCP server offers these values to the requesting host on the network. If the host accepts the offer, the DHCP server leases the IP address for a specific period of time.

Using a DHCP server simplifies the administration of a network because the software keeps track of IP addresses. Automatically configuring TCP/IP also reduces the possibility of assigning duplicate or invalid IP addresses. Before a computer on the network can take advantage of the DHCP server services, the computer must be able to identify the server on the local network. You can configure a computer to accept an IP address from a DHCP server by clicking the **Obtain an IP address automatically** option in the NIC configuration window, as shown in Figure 8-9.

If your computer cannot communicate with the DHCP server to obtain an IP address, the Windows operating system automatically assigns a private IP address. If your computer is assigned an IP address in the range of 169.254.0.0 to 169.254.255.255, it can communicate

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with only other computers in the same range. An example of when these private addresses would be useful is in a classroom lab where you want to prevent access outside to your network. This operating system feature is called Automatic Private IP Addressing (APIPA). APIPA continually requests an IP address from a DHCP server for your computer.

Describe Internet Protocols and Applications

A protocol is a set of rules. Internet protocols are sets of rules governing communication within and between computers on a network. Protocol specifications define the format of the messages that are exchanged. A letter sent through the postal system also uses protocols. Part of the protocol specifies where on the envelope the delivery address needs to be written. If the delivery address is written in the wrong place, the letter cannot be delivered.

Timing is crucial to network operation. Protocols require messages to arrive within a certain amount of time so that computers do not wait indefinitely for messages that may have been lost. Therefore, systems maintain one or more timers during transmission of data. Protocols also initiate alternative actions if the network does not meet the timing rules. Many protocols consist of a suite of other protocols that are stacked in layers. These layers depend on the operation of the other layers in the suite to function properly.

These are the main functions of protocols:

- Identifying errors
- Compressing the data
- Deciding how the data is to be sent
- Addressing the data
- Deciding how to announce sent and received data

Although many other protocols exist, Table 8-1 summarizes the functions of some of the more common protocols used on networks and the Internet.

Table 8-1 Protocol Functions

Protocols	Function
TCP/IP	Transports data on the Internet
NetBEUI/NetBIOS	A small, fast protocol designed for a workgroup network that requires no connection to the Internet
IPX/SPX	Transports data on a Novell NetWare network
HTTP/HTTPS	Defines how files are exchanged on the web
FTP	Provides services for file transfer and manipulation

continues

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Table 8-1 Protocol Functions *continued*

Protocols	Function
SSH	Connects computers securely
Telnet	Uses a text-based connection to a remote TCP/IP computer
POP3	Downloads e-mail messages from an e-mail server
IMAP	Downloads e-mail messages from an e-mail server
SMTP	Sends mail in a TCP/IP network

To understand how networks and the Internet work, you must be familiar with the commonly used protocols. These protocols are used to browse the web, send and receive e-mail, and transfer data files. You will encounter other protocols as your experience in IT grows, but they are not used as often as the common protocols described here:

- ***TCP/IP*:** The TCP/IP suite of protocols has become the dominant standard for internetworking. TCP/IP represents a set of public standards that specify how packets of information are exchanged between computers over one or more networks.
- **IPX/SPX:** Internetwork Packet Exchange/Sequenced Packet Exchange is the protocol suite originally employed by Novell Corporation's network operating system, NetWare. It delivers functions similar to those included in TCP/IP. Novell in its current releases supports the TCP/IP suite. A large installed base of NetWare networks continue to use IPX/SPX.
- **NetBEUI:** NetBIOS Extended User Interface is a protocol used primarily on small Windows NT networks. NetBEUI cannot be routed or used by routers to talk to each other on a large network. NetBEUI is suitable for small peer-to-peer networks, involving a few computers directly connected to each other. It can be used in conjunction with another routable protocol such as TCP/IP. This gives the network administrator the advantages of the high performance of NetBEUI within the local network and the ability to communicate beyond the LAN over TCP/IP.
- **AppleTalk:** AppleTalk is a protocol suite to network Macintosh computers. It is composed of a comprehensive set of protocols that span the seven layers of the Open Systems Interconnection (OSI) reference model. The AppleTalk protocol was designed to run over LocalTalk, which is the Apple LAN physical topology. This protocol is also designed to run over major LAN types, notably Ethernet and Token Ring.
- ***HTTP*:** Hypertext Transfer Protocol governs how files such as text, graphics, sound, and video are exchanged on the World Wide Web (WWW). The Internet Engineering Task Force (IETF) developed the standards for HTTP.
- ***FTP*:** File Transfer Protocol provides services for file transfer and manipulation. FTP allows multiple simultaneous connections to remote file systems.

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- **SSH:** Secure Shell is used to securely connect to a remote computer.
- ***Telnet*:** An application used to connect to a remote computer that lacks security features.
- **POP3:** Post Office Protocol is used to download e-mail from a remote mail server.
- **IMAP:** Internet Message Access Protocol is also used to download e-mail from a remote mail server.
- ***SMTP*:** Simple Mail Transfer Protocol is used to send e-mail to a remote e-mail server.

The more you understand about each of these protocols, the more you will understand how networks and the Internet work.

Define ICMP

Devices on a network use ***Internet Control Message Protocol (ICMP)*** to send control and error messages to computers and servers. ICMP has several different uses, such as announcing network errors, announcing network congestion, and troubleshooting.

Packet Internet groper (ping) is commonly used to test connections between computers. Ping is a simple but highly useful command-line utility that determines whether a specific IP address is accessible. You can ping the IP address to test IP connectivity. Ping works by sending an ICMP echo request to a destination computer or other network device. The receiving device then sends back an ICMP echo reply message to confirm connectivity.

Ping is a troubleshooting tool used to determine basic connectivity. Example 8-1 shows the command-line switches that can be used with the **ping** command. Four ICMP echo requests (pings) are sent to the destination computer. If it can be reached, the destination computer responds with four ICMP echo replies. The percentage of successful replies can help you determine the reliability and accessibility of the destination computer.

Example 8-1 ping Command Switches

```
C:\> ping /?

Usage: ping [-t] [-a] [-n count] [-l size] [-f] [-i TTL] [-v TOS]
            [-r count] [-s count] [[-j host-list] ¦ [-k host-list]]
            [-w timeout] target_name

Options:
    -t              Ping the specified host until stopped.
                    To see statistics and continue - type Control-Break;
                    To stop - type Control-C.
    -a              Resolve addresses to hostnames.
    -n count        Number of echo requests to send.
```

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```
    -l size         Send buffer size.
    -f              Set Don't Fragment flag in packet.
    -i TTL          Time To Live.
    -v TOS          Type Of Service.
    -r count        Record route for count hops.
    -s count        Timestamp for count hops.
    -j host-list    Loose source route along host-list.
    -k host-list    Strict source route along host-list.
    -w timeout      Timeout in milliseconds to wait for each reply.
```

You can also use ping to find a host's IP address when you know the name. If you ping the name of a website, such as www.cisco.com, as shown in Example 8-2, the server's IP address appears.

Example 8-2 Using the ping Command to Find an IP Address

```
C:\> ping cisco.com

Pinging cisco.com [198.133.219.25] with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping statistics for 198.133.219.25:
    Packets: Sent = 4, Received = 0, Lost = 4 (100% loss),
```

Other ICMP messages are used to report undelivered packets, data on an IP network that includes source and destination IP addresses, and whether a device is too busy to handle the packet. Data, in the form of a packet, arrives at a router, which is a networking device that forwards data packets across networks toward their destinations. If the router does not know where to send the packet, the router deletes it. The router then sends an ICMP message back to the sending computer, informing it that the data was deleted. When a router becomes very busy, it may send a different ICMP message to the sending computer, indicating that it should slow down because the network is congested.

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Describe the Physical Components of a Network

Many devices can be used in a network to provide connectivity, as shown in Figure 8-10. Which device you use depends on how many devices you are connecting, the type of connections they use, and the speed at which the devices operate. These are the most common devices on a network:

- Computers
- Hubs
- Switches
- Routers
- Wireless access points

Figure 8-10 Physical Network Components



The physical components of a network are needed to move data between these devices. The characteristics of the media determine where and how the components are used. These are the most common media used on networks:

- Twisted pair
- Fiber-optic cabling
- Radio waves

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After completing this section, you will meet these objectives:

- Identify the names, purposes, and characteristics of network devices.
- Identify the names, purposes, and characteristics of common network cables.

Identify the Names, Purposes, and Characteristics of Network Devices

To make data transmission more extensible and efficient than a simple peer-to-peer network, network designers use specialized network devices such as hubs, switches, routers, and wireless access points to send data between devices.

Hubs

Hubs, shown in Figure 8-11, are devices that extend a network's range by receiving data on one port and then regenerating the data and sending it out to all other ports. This process means that all traffic from a device connected to the hub is sent to all the other devices connected to the hub every time the hub transmits data. This causes a large amount of network traffic. Hubs are also called concentrators because they serve as a central connection point for a LAN. They are also sometimes called multiport repeaters because they send data out all the ports.

Figure 8-11 Hub



Bridges and Switches

Files are broken into small pieces of data, called packets, before they are transmitted over a network. This process allows for error checking and easier retransmission if the packet is

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lost or corrupted. Address information is added to the beginning and end of packets before they are transmitted. The packet, along with the address information, is called a frame.

LANs are often divided into sections called segments, similar to how a company is divided into departments. The boundaries of segments can be defined using a bridge. A ***bridge*** is a device used to filter network traffic between LAN segments. Bridges keep a record of all the devices on each segment to which the bridge is connected. When the bridge receives a frame, it examines the destination address to determine if the frame is to be sent to a different segment, or dropped. The bridge also helps improve the flow of data by keeping frames confined to only the segment to which the frame belongs.

Switches, shown in Figure 8-12, are sometimes called multiport bridges. A typical bridge may have just two ports, linking two segments of the same network. A switch has several ports, depending on how many network segments are to be linked. A switch is a more sophisticated device than a bridge. A switch maintains a table of the MAC addresses for computers that are connected to each port. When a frame arrives at a port, the switch compares the address information in the frame to its MAC address table. The switch then determines which port to use to forward the frame.

Figure 8-12 Switch



Routers

Whereas a switch connects segments of a network, ***routers***, shown in Figure 8-13, are devices that connect entire networks to each other. Switches use MAC addresses to forward a frame within a single network. Routers use IP addresses to forward frames to other networks. A router can be a computer with special network software installed, or it can be a device built by network equipment manufacturers. Routers contain tables of IP addresses along with optimal destination routes to other networks.

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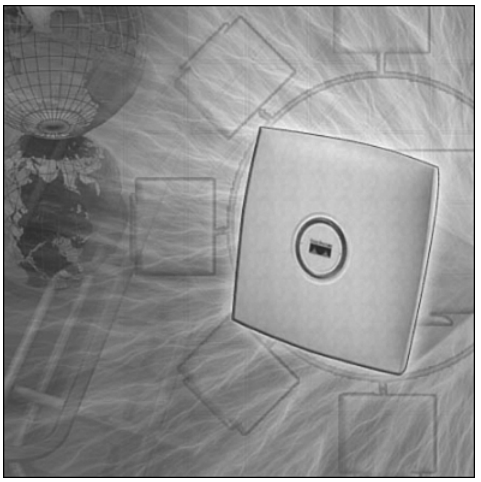
Figure 8-13 Routers



Wireless Access Points

Wireless access points, shown in Figure 8-14, provide network access to wireless devices such as laptops and PDAs. The wireless access point uses radio waves to communicate with radios in computers, PDAs, and other wireless access points. An access point has a limited range of coverage. Large networks require several access points to provide adequate wireless coverage.

Figure 8-14 Wireless Access Point



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Multipurpose Devices

Some network devices perform more than one function. It is more convenient to purchase and configure one device that serves all your needs than to purchase a separate device for each function. This is especially true for the home user. In your home, you would purchase a multipurpose device instead of a switch, a router, and a wireless access point. The Linksys 300N, shown in Figure 8-15, is an example of a multipurpose device.

Figure 8-15 Multipurpose Device



Identify the Names, Purposes, and Characteristics of Common Network Cables

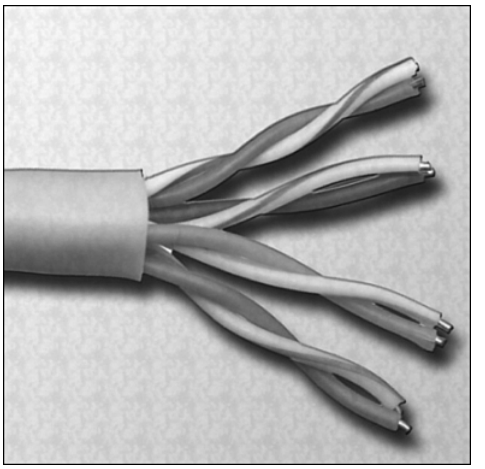
Until recently, cables were the only medium used to connect devices on networks. A wide variety of networking cables are available. Coaxial and twisted-pair cables use copper to transmit data. Fiber-optic cables use glass or plastic to transmit data. These cables differ in bandwidth, size, and cost. You need to know what type of cable to use in different situations so that you install the correct cables for the job. You also need to be able to troubleshoot and repair problems you encounter.

Twisted Pair

Twisted pair is a type of copper cabling that is used for telephone communications and most Ethernet networks. A pair of wires forms a circuit that can transmit data. The pair is twisted to provide protection against crosstalk, which is the noise generated by adjacent pairs of wires in the cable. Pairs of copper wires are encased in color-coded plastic insulation and are twisted together. An outer jacket protects the bundles of twisted pairs. Figure 8-16 shows a twisted-pair cable.

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Figure 8-16 Twisted-Pair Cabling



When electricity flows through a copper wire, a magnetic field is created around the wire. A circuit has two wires, and in a circuit, the two wires have oppositely-charged magnetic fields. When the two wires of the circuit are next to each other, the magnetic fields cancel each other out. This is called the cancellation effect. Without the cancellation effect, your network communications become slow because of the interference caused by the magnetic fields.

The two basic types of twisted-pair cables are as follows:

- ***Unshielded twisted pair (UTP)*** is cable that has two or four pairs of wires. This type of cable relies solely on the cancellation effect produced by the twisted-wire pairs that limits signal degradation caused by electromagnetic interface (EMI) and radio frequency interference (RFI). UTP is the most commonly used cabling in networks. UTP cables have a range of 328 feet (100 m).
- With ***shielded twisted pair (STP)***, each pair of wires is wrapped in metallic foil to better shield the wires from noise. Four pairs of wires are then wrapped in an overall metallic braid or foil. STP reduces electrical noise from within the cable. It also reduces EMI and RFI from outside the cable.

Although STP prevents interference better than UTP, STP is more expensive because of extra shielding. It also is more difficult to install because of the thickness. In addition, the metallic shielding must be grounded at both ends. If it's improperly grounded, the shield acts like an antenna, picking up unwanted signals. STP is primarily used outside North America. STP cables also have a range of 328 feet (100 m).

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Category Rating

UTP comes in several categories that are based on two factors:

- The number of wires in the cable
- The number of twists in those wires

Category 3 is the wiring used for telephone systems and Ethernet LAN at 10 Mbps. Category 3 has four pairs of wires.

Category 5 and Category 5e have four pairs of wires with a transmission rate of 100 Mbps. Category 5 and Category 5e are the most common network cables used. Category 5e has more twists per foot than Category 5 wiring. These extra twists further prevent interference from outside sources and the other wires within the cable.

Some Category 6 cables use a plastic divider to separate the pairs of wires, which prevents interference. The pairs also have more twists than Category 5e cable.

Coaxial Cable

Coaxial cable is a copper-cored cable surrounded by a heavy shielding, as shown in Figure 8-17. Coaxial cable is used to connect the computers to the rest of the network. Coaxial cable uses BNC connectors, sometimes called "British Naval Connectors" or "Bayonet Neill-Concelman" connectors, at the ends of the cables to make the connection. Several types of coaxial cable exist:

- ***Thicknet (10BASE5)*** is coaxial cable that was used in networks and operated at 10 Mbps, with a maximum length of 500 meters.
- ***Thinnet (10BASE2)*** is coaxial cable that was used in networks and operated at 10 Mbps, with a maximum length of 185 meters.
- **RG-59** is most commonly used for cable television in the U.S.
- **RG-6** is higher-quality cable than RG-59, with more bandwidth and less susceptibility to interference.

Fiber-Optic Cable

An optical fiber is a glass or plastic conductor that transmits information using light. ***Fiber-optic cable***, shown in Figure 8-18, has one or more optical fibers enclosed in a sheath or jacket. Because it is made of glass, fiber-optic cable is not affected by EMI or RFI. All signals are converted to light pulses to enter the cable and are converted back into electrical signals when they leave it. This means that fiber-optic cable can deliver signals that are clearer, that can go farther, and that have greater bandwidth than cable made of copper or other metals.

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Figure 8-17 Coaxial Cabling

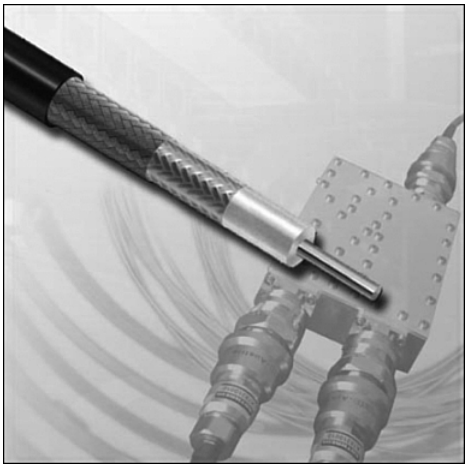


Figure 8-18 Fiber-Optic Cabling



Fiber-optic cable can reach distances of several miles or kilometers before the signal needs to be regenerated. Fiber-optic cable usually is more expensive to use than copper cable, and the connectors are more costly and harder to assemble. Common connectors for fiber-optic networks are SC, ST, and LC. These three types of fiber-optic connectors are half-duplex, which allows data to flow in only one direction. Therefore, two cables are needed.

These are the two types of glass fiber-optic cable:

- ***Multimode*** is cable that has a thicker core than single-mode cable. It is easier to make, can use simpler light sources (LEDs), and works well over distances of a few kilometers or less.

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- ***Single-mode*** is cable that has a very thin core. It is harder to make, uses lasers as a light source, and can transmit signals dozens of kilometers with ease.

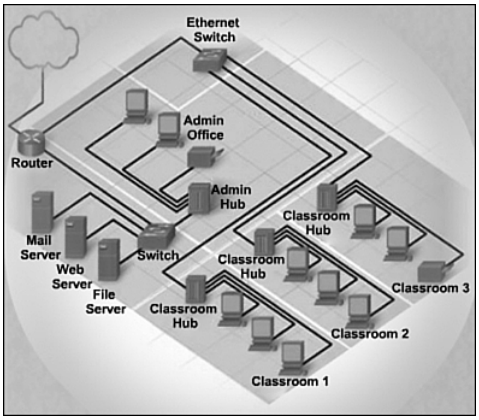
A fiber-optic cable is one or more optical fibers enclosed together in a sheath or jacket.

Describe LAN Topologies and Architectures

Most of the computers that you work on will be part of a network. Topologies and architectures are building blocks for designing a computer network. Although you may not build a computer network, you need to understand how they are designed so that you can work on computers that are part of a network.

The two types of LAN topologies are physical and logical. A physical topology, shown in Figure 8-19, is the physical layout of the components on the network. A ***logical topology***, shown in Figure 8-20, determines how the hosts communicate across a medium, such as a cable or the airwaves. Topologies commonly are represented as network diagrams.

Figure 8-19 Physical Topology



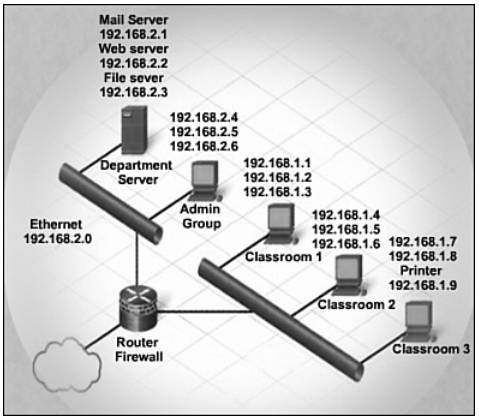
A LAN architecture is built around a topology. A LAN architecture comprises all the components that make up the structure of a communications system. These components include the hardware, software, protocols, and sequence of operations.

After completing this section, you will meet these objectives:

- Describe LAN topologies.
- Describe LAN architectures.

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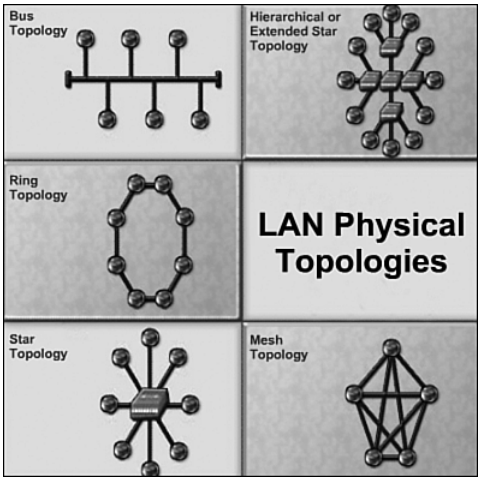
Figure 8-20 Logical Topology



Describe LAN Topologies

A physical topology defines the way in which computers, printers, and other devices are connected to a network. A logical topology describes how the hosts access the medium and communicates on the network. The type of topology, as shown in Figure 8-21, determines the network's capabilities, such as ease of setup, speed, and cable lengths.

Figure 8-21 LAN Physical Topologies



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Physical Topologies

The common LAN physical topologies are as follows:

- ***Bus topology*:** In the bus topology, each computer connects to a common cable. The cable connects one computer to the next, like a bus line going through a city. The cable has a small cap installed at the end, called a terminator. The terminator prevents signals from bouncing back and causing network errors.
- ***Ring topology*:** In a ring topology, hosts are connected in a physical ring or circle. Because the ring topology has no beginning or end, the cable does not need to be terminated. A specially formatted frame, called a token, travels around the ring, stopping at each host. If a host wants to transmit data, it adds the data and the destination address to the frame. The frame then continues around the ring until it stops at the host with the destination address. The destination host takes the data out of the frame.
- ***Star topology*:** The star topology has a central connection point, which normally is a device such as a hub, switch, or router. Each host on a network has a cable segment that attaches the host directly to the central connection point. The advantage of a star topology is that it is easy to troubleshoot. Each host is connected to the central device with its own wire. If there is a problem with that cable, only that host is affected. The rest of the network remains operational.
- ***Hierarchical or extended star topology*:** A hierarchical or extended star topology is a star network with an additional networking device connected to the main networking device. Typically, a network cable connects to one hub, and then several other hubs connect to the first hub. Larger networks, such as those of corporations or universities, use the hierarchical star topology.
- ***Mesh topology*:** The mesh topology connects all devices to each other. When every device is connected to every other device, a failure of any cable does not affect the network. The mesh topology is used in WANs that interconnect LANs.

Logical Topologies

The two most common types of logical topologies are broadcast and token passing.

In a broadcast topology, each host addresses data to either a particular host or to all hosts connected on a network. There is no order that the hosts must follow to use the network. It is first come, first served for transmitting data on the network.

Token passing controls network access by passing an electronic token sequentially to each host. When a host receives the token, it can send data on the network. If the host has no data to send, it passes the token to the next host, and the process repeats.

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Describe LAN Architectures

A LAN architecture describes both the physical and logical topologies used in a network. Table 8-2 lists the three most common LAN architectures.

Table 8-2 LAN Architectures

Architecture	Physical Topology	Logical Topology
Ethernet	Bus	
Star		
Extended star	Bus	
Token Ring	Star	Ring
Fiber Distributed Data Interface (FDDI)	Double ring	Ring

Ethernet

The ***Ethernet*** architecture is based on the IEEE 802.3 standard. The IEEE 802.3 standard specifies that a network must use the carrier sense multiple access collision detect (CSMA/CD) access control method. In CSMA/CD, hosts access the network using the first-come, first-served broadcast topology method to transmit data.

Ethernet uses a logical bus or broadcast topology and either a bus or star physical topology. As networks expand, most Ethernet networks are implemented using an extended star or hierarchical star topology. Standard transfer rates are 10 Mbps and 100 Mbps, but new standards outline Gigabit Ethernet, which can attain speeds of up to 1000 Mbps (1 Gbps).

Token Ring

IBM originally developed ***Token Ring*** as a reliable network architecture based on the token-passing access control method. Token Ring is used with computers and mainframes.

Token Ring is an example of an architecture in which the physical topology is different from its logical topology. The Token Ring topology is called a star-wired ring because the outer appearance of the network design is a star. The computers connect to a central hub, called a multistation access unit (MSAU). Inside the device, however, the wiring forms a circular data path, creating a logical ring. The logical ring is created by the token traveling out of an MSAU port to a computer. If the computer does not have any data to send, the token is sent back to the MSAU port and then out the next port to the next computer. This process continues for all computers and therefore resembles a physical ring.

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FDDI

FDDI is a type of Token Ring network. The implementation and topology of FDDI differs from the IBM Token Ring LAN architecture. FDDI is often used to connect several buildings in an office complex or on a university campus.

FDDI runs on fiber-optic cable. FDDI combines high-speed performance with the advantages of the token-passing ring topology. FDDI runs at 100 Mbps on a dual-ring topology. The outer ring is called the primary ring, and the inner ring is called the secondary ring.

Normally, traffic flows on only the primary ring. If the primary ring fails, the data automatically flows onto the secondary ring in the opposite direction.

An FDDI dual ring supports a maximum of 500 computers per ring. The total distance of each length of the cable ring is 62 miles (100 km). A repeater, which is a device that regenerates signals, is required every 1.2 miles (2 km). In recent years, many Token Ring networks have been replaced by faster Ethernet networks.

Identify Standards Organizations

Several worldwide standards organizations are responsible for setting networking standards. Manufacturers use standards as a basis for developing technology, especially communications and networking technologies. Standardizing technology ensures that the devices you use are compatible with other devices using the same technology. Standards groups create, examine, and update standards. These standards are applied to the development of technology to meet the demands for higher bandwidth, efficient communication, and reliable service.

Here is a list of standards organizations:

- **IEEE:** The Institute of Electrical and Electronic Engineers is a nonprofit technical professional association of more than 377,000 members in 150 countries. Founded in 1884, the organization is composed of engineers, scientists, and students. Through its members, the IEEE is a leading authority in technical areas ranging from computer engineering, biomedical technology, and telecommunications to electric power, aerospace, and consumer electronics.
- **ISO:** The International Organization for Standardization is an international organization composed of national standards bodies from more than 140 countries. The American National Standards Institute (ANSI), for example, is a member of ISO. ISO is a nongovernment organization established to promote the development of standardization and related activities. ISO's work results in international agreements, which are published as International Standards.

  ISO has defined a number of important computer standards, the most significant of which is perhaps the OSI model, a standardized architecture for designing networks.

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ISO together with the International Electrotechnical Commission (IEC) and the International Telecommunication Union (ITU) have built a strategic partnership with the World Trade Organization (WTO).

- **IAB:** The Internet Architecture Board is the committee that oversees the technical and engineering development of the Internet by the Internet Society (ISOC). The committee oversees the Internet Engineering Task Force (IETF) and the Internet Research Task Force (IRTF). When the Internet transitioned to a public entity in 1992, the name was changed to what it is today, the Internet Architecture Board, originally formed by the U.S. Department of Defense.

- **IEC:** Founded in 1906, the International Electrotechnical Commission is the global organization that prepares and publishes international standards for all electrical, electronic, and related technologies. The IEC was founded because of a resolution passed at the International Electrical Congress held in St. Louis (U.S.) in 1904. The membership consists of more than 60 participating countries, including all the world's major trading nations and a growing number of industrialized countries. The IEC's mission is to promote, through its members, international cooperation on all questions related to electrotechnologies, electroacoustics, multimedia, telecommunications, and energy production and distribution, as well as associated general disciplines such as terminology and symbols, electromagnetic compatibility, design and development, safety, and the environment.

  The IEC is one of the bodies recognized by the World Trade Organization (WTO) and entrusted by it to monitor the national and regional organizations agreeing to use the IEC's international standards as the basis of national or regional standards as part of the WTO's Technical Barriers to Trade Agreement.

- **ANSI:** The American National Standards Institute is a private, nonprofit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment system. ANSI identifies industrial and public requirements for national consensus standards and coordinates and manages their development, resolves national standards problems, and ensures effective participation in international standardization. Since 1918, the institute's mission has been to enhance both the global competitiveness of U.S. business and quality of life by promoting and facilitating voluntary consensus standards and conformity assessment systems and safeguarding their integrity.

  ANSI does not develop standards itself. Rather, it facilitates development by establishing consensus processes among qualified groups. This is why its acronym is seen on many standards.

- ***TIA/EIA*:** The Telecommunications Industry Association (TIA) and Electronic Industries Association (EIA) are trade associations that jointly develop and publish a series of standards covering structured voice and data wiring for LANs. These industry

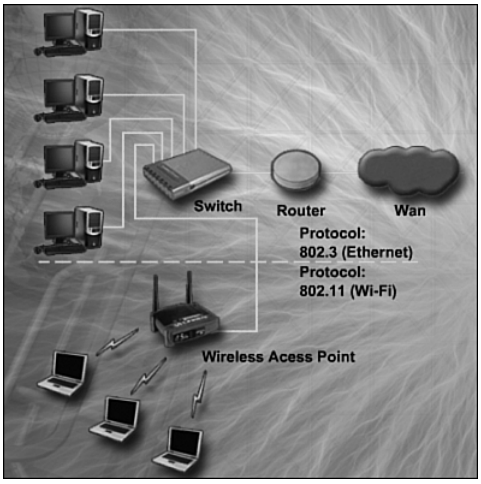
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standards evolved after the U.S. telephone industry deregulation in 1984, which transferred responsibility for on-premises cabling to the building owner. Before that, AT&T used proprietary cables and systems. :

Identify Ethernet Standards

Ethernet protocols describe the rules that control how communication occurs on an Ethernet network. To ensure that all Ethernet devices are compatible with each other, the IEEE developed standards for manufacturers and programmers to follow when developing Ethernet devices. Figure 8-22 shows an example of how different devices can communicate using these standards.

Figure 8-22 Interoperability Between Standards



After completing this section, you will meet these objectives:

- Explain cabled Ethernet standards.
- Explain wireless Ethernet standards.

Explain Cabled Ethernet Standards

The Ethernet architecture is based on the IEEE 802.3 standard. The ***IEEE 802.3*** standard specifies that a network must implement the CSMA/CD access control method.

In ***CSMA/CD***, all end stations "listen" to the network wire for clearance to send data. This process is similar to waiting to hear a dial tone on a phone before dialing a number. When the end station detects that no other host is transmitting, it attempts to send data. If no other

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station sends data at the same time, the transmission arrives at the destination computer with no problems. If another end station observes the same clear signal and transmits at the same time, a collision occurs on the network medium.

The first station that detects the collision, or the doubling of voltage, sends out a jam signal that tells all stations to stop transmitting and to run a backoff algorithm. A backoff algorithm calculates random times at which the end station retries the network transmission. This random time typically is one or two milliseconds (ms), or thousandths of a second. This sequence occurs every time a collision occurs on the network and can reduce Ethernet transmission by up to 40 percent.

Ethernet Technologies

The IEEE 802.3 standard defines several physical implementations that support Ethernet. Some of the common implementations are described here.

Ethernet

10BASE-T is an Ethernet technology that uses a star topology. 10BASE-T is a popular Ethernet architecture whose features are indicated in its name:

- The 10 represents a speed of 10 Mbps.
- BASE represents baseband transmission. In baseband transmission, the entire bandwidth of a cable is used for one type of signal.
- The T represents twisted-pair copper cabling.

The advantages of 10BASE-T are as follows:

- Installation of cable is inexpensive compared to fiber-optic installation.
- Cables are thin, flexible, and easier to install than coaxial cabling.
- Equipment and cables are easy to upgrade.

The disadvantages of 10BASE-T are as follows:

- The maximum length of a 10BASE-T segment is only 328 feet (100 m).
- Cables are susceptible to EMI.

Fast Ethernet

The high-bandwidth demands of many modern applications, such as videoconferencing and streaming audio, have created a need for higher data-transfer speeds. Many networks require more bandwidth than 10 Mbps Ethernet.

100BASE-TX is much faster than 10BASE-T and has a theoretical bandwidth of 100 Mbps.

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The advantages of 100BASE-TX are as follows:

- At 100 Mbps, transfer rates of 100BASE-TX are ten times that of 10BASE-T.
- 100BASE-X uses twisted-pair cabling, which is inexpensive and easy to install.

The disadvantages of 100BASE-TX are as follows:

- The maximum length of a 100BASE-TX segment is only 328 feet (100 m).
- Cables are susceptible to EMI.

Gigabit Ethernet

1000BASE-T is commonly known as Gigabit Ethernet. Gigabit Ethernet is a LAN architecture.

The advantages of 1000BASE-T are as follows:

- The 1000BASE-T architecture supports data transfer rates of 1 Gbps. At 1 Gbps, it is ten times faster than Fast Ethernet and 100 times faster than Ethernet. This increased speed makes it possible to implement bandwidth-intensive applications, such as live video.
- The 1000BASE-T architecture is interoperable with 10BASE-T and 100BASE-TX.

The disadvantages of 1000BASE-T are as follows:

- The maximum length of a 1000BASE-T segment is only 328 feet (100 m).
- It is susceptible to interference.
- Gigabit NICs and switches are expensive.
- Additional equipment is required.

Summary of Ethernet Technologies

Table 8-3 summarizes the Ethernet standards.

Table 8-3 Cabled Ethernet Standards

	10BASE-T	100BASE-TX	1000BASE-T
Media	EIA/TIA Category 3, 4, 5 UTP, two pair	EIA/TIA Category 5, 5e UTP, two pair	EIA/TIA Category 5, 5e UTP, four pair
Maximum Segment Length	100 m (328 feet)	100 m (328 feet)	100 m (328 feet)
Topology	Star	Star	Star
Connector	ISO 8877 (RJ-45)	IOS 8877 (RJ-45)	ISO 8877 (RJ-45)

10BASE-FL, 100BASE-FX, 1000BASE-SX, and LX are fiber-optic Ethernet technologies.

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Explain Wireless Ethernet Standards

IEEE 802.11 is the standard that specifies connectivity for wireless networks. IEEE 802.11, or Wi-Fi, refers to the collective group of standards—802.11a, 802.11b, 802.11g, and 802.11n. These protocols specify the frequencies, speeds, and other capabilities of the different Wi-Fi standards:

- ***802.11a***: Devices conforming to the 802.11a standard allow WLANs to achieve data rates as high as 54 Mbps. IEEE 802.11a devices operate in the 5-GHz radio frequency range and within a maximum range of 150 feet (45.7 m).
- ***802.11b***: 802.11b operates in the 2.4-GHz frequency range, with a maximum theoretical data rate of 11 Mbps. These devices operate within a maximum range of 300 feet (91 m).
- ***802.11g***: IEEE 802.11g provides the same theoretical maximum speed as 802.11a, which is 54 Mbps, but operates in the same 2.4-GHz spectrum as 802.11b. Unlike 802.11a, 802.11g is backward-compatible with 802.11b. 802.11g also has a maximum range of 300 feet (91 m).
- ***802.11n***: 802.11n is a newer wireless standard that has a theoretical bandwidth of 540 Mbps and operates in either the 2.4-GHz or 5-GHz frequency range with a maximum range of 984 feet (250 m).

Table 8-4 summarizes Wireless Ethernet standards.

Table 8-4 Wireless Ethernet Standards

Standard	Bandwidth	Frequency	Range	Interoperability
IEEE 802.11a	Up to 54 Mbps	5-GHz band	150 ft (45.7 m)	Not interoperable with 802.11b, 802.11g, and 802.11n
IEEE 802.11b	Up to 11 Mbps	2.4-GHz band	300 ft (91 m)	Interoperable with 802.11g
IEEE 802.11g	Up to 54 Mbps	2.4-GHz band	300 ft (91 m)	Interoperable with 802.11b
IEEE 802.11n (prestandard)	Up to 540 Mbps	2.4-GHz or 5-GHz band	984 ft (250 m)	Interoperable with 802.11b and 802.11g

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Explain the OSI and TCP/IP Data Models

An architectural model is a common frame of reference for explaining Internet communications and developing communication protocols. It separates the functions of protocols into manageable layers. Each layer performs a specific function in the process of communicating over a network.

The TCP/IP model was created by researchers in the U.S. Department of Defense (DoD). The TCP/IP model is a tool used to help explain the TCP/IP suite of protocols, which is the dominant standard for transporting data across networks. This model has four layers, as shown in Table 8-5.

Table 8-5 TCP/IP Model Versus the OSI Model

TCP/IP Model	OSI Model
Application	Application
Presentation	
Session	
Transport	Transport
Internet	Network
Network access	Data link
Physical	

In the early 1980s, the ISO developed the Open Systems Interconnection (OSI) model, which was defined in ISO standard 7498-1, to standardize how devices communicate on a network. This model has seven layers, as shown in Table 8-5. This model was a major step toward ensuring that network devices could interoperate.

After completing this section, you will meet these objectives:

- Define the TCP/IP model.
- Define the OSI model.
- Compare the OSI and TCP/IP models.

Define the TCP/IP Model

The TCP/IP reference model provides a common frame of reference for developing the protocols used on the Internet. It consists of layers that perform functions necessary to prepare data for transmission over a network. Table 8-6 describes the four layers of the TCP/IP model.

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Table 8-6 TCP/IP Model

TCP/IP Model	Layer	Description
Application	4	Where high-level protocols such as SMTP and FTP operate
Transport	3	Where flow-control and connection protocols exist
Internet	2	Where IP addressing and routing take place
Network access	1	Where MAC addressing and physical network components exist

A message begins at the top layer, the application layer, and moves down the TCP/IP layers to the bottom layer, the network access layer. Header information is added to the message as it moves down through each layer and then is transmitted. After reaching the destination, the message travels back up through each layer of the TCP/IP model. The header information that was added to the message is stripped away as the message moves up through the layers toward its destination.

Application Protocols

Application layer protocols provide network services to user applications such as web browsers and e-mail programs. Here are some of the ***application protocols*** that operate at the TCP/IP application layer:

- **Hypertext Transfer Protocol (HTTP)** governs how files such as text, graphics, sound, and video are exchanged on the Internet or World Wide Web (WWW). HTTP is an application layer protocol. A web server runs an HTTP service or daemon. A daemon is a program that services HTTP requests. These requests are transmitted by HTTP client software, which is another name for a web browser.
- **Telnet** is an application that you can use to access, control, and troubleshoot remote computers and network devices.
- **File Transfer Protocol (FTP)** is a set of rules governing how files are transferred. FTP allows multiple simultaneous connections to remote file systems.
- **Simple Mail Transport Protocol (SMTP)** provides messaging services over TCP/IP and supports most Internet e-mail programs.
- ***Domain Name System (DNS)*** translates domain names, such as www.cisco.com, to IP addresses.
- ***Hypertext Markup Language (HTML)*** is a page description language. Web designers use HTML to indicate to web browser software how the page should look. HTML includes tags to indicate boldface and italic type, line breaks, paragraph breaks, hyperlinks, and insertion of tables, among other instructions.

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Transport Protocols

Transport layer protocols provide end-to-end management of the data. One of the functions of these protocols is to divide the data into manageable segments for easier transport across the network. Here are the two ***transport protocols*** that operate at the TCP/IP transport layer:

- ***Transmission Control Protocol (TCP)*** is the primary Internet protocol for the reliable delivery of data. TCP includes facilities for end-to-end connection establishment, error detection and recovery, and metering the rate of data flow into the network. Many standard applications, such as e-mail, web browser, file transfer, and Telnet, depend on the services of TCP.
- ***User Datagram Protocol (UDP)*** offers a connectionless service for delivery of data. UDP uses lower overhead than TCP and doesn't handle issues of reliability. Network management applications, network file system, and simple file transport use UDP.

Internet Protocols

Internet layer protocols operate at the third layer from the top in the TCP/IP model. Internet protocols are used to provide connectivity between hosts in the network. Here are some of the protocols that operate at the TCP/IP Internet layer:

- ***Internet Protocol (IP)*** provides source and destination addressing, much like the address and return address on a postal envelope. In conjunction with routing protocols, IP provides packet-forwarding information from one network to another.
- **Internet Control Message Protocol (ICMP)** is used for network testing and troubleshooting. It enables diagnostic and error messages. The ping application uses ICMP echo messages to test if a remote device can be reached.
- ***Routing information Protocol (RIP)*** operates between router devices to discover paths between networks. In an intranet, routers depend on a routing protocol to build and maintain information about how to forward packets toward the destination. RIP chooses routes based on the distance or hop count to the destination.
- ***Address Resolution Protocol (ARP)*** is used to map the MAC address of a node on the network when its IP address is known. End stations as well as routers use ARP to discover MAC addresses.

Network Access Protocols

Network access protocols describe the standards that hosts use to access the physical media. The IEEE 802.3 Ethernet standards and technologies, such as CSMA/CD and 10BASE-T, are defined at this layer.

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Define the OSI Model

The OSI model is an industry-standard framework that is used to divide network communications into seven distinct layers. Although other models exist, most network vendors today build their products using this framework.

A system that implements protocol behavior consisting of a series of these layers is known as a protocol stack. Protocol stacks can be implemented in either hardware or software, or a combination of both. Typically, only the lower layers are implemented in hardware, and the higher layers are implemented in software.

Each layer is responsible for part of the processing to prepare data for transmission on the network. Table 8-7 describes each layer of the OSI model.

Table 8-7 OSI Model

OSI Model	Layer	Description
Application	7	Responsible for network services to applications
Presentation	6	Transforms data formats to provide a standard interface for the application layer
Session	5	Establishes, manages, and terminates the connections between the local and remote applications
Transport	4	Provides reliable transport and flow control across a network
Network	3	Responsible for logical addressing and the domain of routing
Data link	2	Provides physical addressing and media access procedures
Physical	1	Defines all the electrical and physical specifications for devices

In the OSI model, when data is transferred, it is said to virtually travel down the OSI model layers of the sending computer and up the OSI model layers of the receiving computer.

When a user wants to send data, such as an e-mail, the encapsulation process starts at the application layer. The application layer provides network access to applications. Information flows through the top three layers and is considered to be data when it gets down to the transport layer.

At the transport layer, the data is broken into more manageable segments, or transport layer protocol data units (PDU), for orderly transport across the network. A PDU describes data as it moves from one layer of the OSI model to another. The transport layer PDU also contains information such as port numbers, sequence numbers, and acknowledgment numbers, which is used for reliable data transport.

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At the network layer, each segment from the transport layer becomes a packet. The packet contains logical addressing and other Layer 3 control information.

At the data link layer, each packet from the network layer becomes a frame. The frame contains physical address and error-correction information.

At the physical layer, the frame becomes bits. These bits are transmitted one at a time across the network medium.

At the receiving computer, the de-encapsulation process reverses the process of encapsulation. The bits arrive at the physical layer of the OSI model of the receiving computer. The process of virtually traveling up the OSI model of the receiving computer brings the data to the application layer, where an e-mail program displays the e-mail.

Note

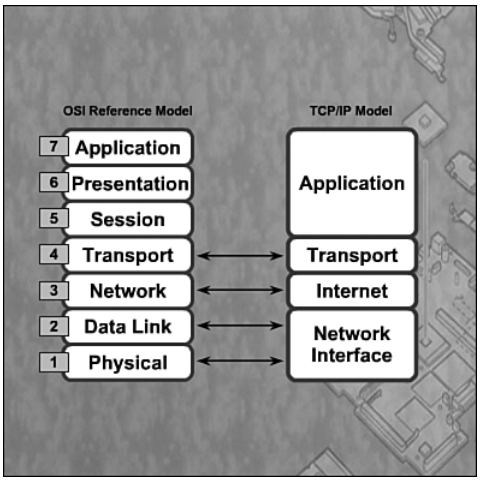
Mnemonics can help you remember the seven layers of the OSI. Two examples are "All People Seem To Need Data Processing" and "Please Do Not Throw Sausage Pizza Away."

Compare the OSI and TCP/IP Models

The OSI model and the TCP/IP model are both reference models used to describe the data communication process. The TCP/IP model is used specifically for the TCP/IP suite of protocols. The OSI model is used to develop standard communication for equipment and applications from different vendors.

The TCP/IP model performs the same process as the OSI model, but it uses four layers instead of seven. Figure 8-23 shows how the layers of the two models compare.

Figure 8-23 OSI Model and TCP/IP Model Compared



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Describe How to Configure a NIC and a Modem

A network interface card (NIC) is required to connect to the Internet. The NIC may come preinstalled, or you may have to purchase one. In rare cases, you may need to update the ***NIC driver***. You can use the driver disc that comes with the motherboard or adapter card, or you can supply a driver that you downloaded from the manufacturer.

After the NIC and the driver have been installed, you can connect the computer to the network.

In addition to installing a NIC, you may need to install a modem to connect to the Internet.

After completing this section, you will meet these objectives:

- Install or update a NIC driver.
- Attach the computer to an existing network.
- Describe the installation of a modem.

Install or Update a NIC Driver

Sometimes a manufacturer publishes new driver software for a NIC. A new driver may enhance the functionality of the NIC, or it may be needed for operating system compatibility.

When installing a new driver, be sure to disable virus protection software so that none of the files is incorrectly installed. Some virus scanners detect a driver update as a possible virus attack. Also, only one driver should be installed at a time; otherwise, some updating processes may conflict.

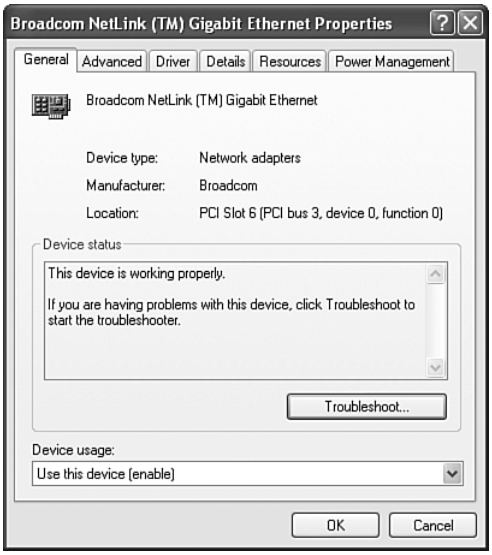
A best practice is to close all applications that are running so that they do not use any files associated with the driver update. Before updating a driver, you should visit the manufacturer's website. In many cases, you can download a self-extracting executable driver file that automatically installs or updates the driver. Alternatively, you can click the Update Driver button in the Device Manager toolbar.

The + next to the Network adapters category allows you to expand the category and show the network adapters installed in your system. To view and change the adapter's properties, or update the driver, double-click the adapter. In the adapter properties window, click the Driver tab. Figure 8-24 shows an example of a network card adapter properties page in Device Manager.

When the update is complete, it is a good idea to reboot the computer, even if you do not receive a message telling you to do so. Rebooting the computer ensures that the installation has gone as planned and that the new driver is working properly. When installing multiple drivers, reboot the computer between each update to make sure that no conflicts exist. This step takes extra time but ensures a clean installation of the driver.

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Figure 8-24 Adapter Properties in Device Manager



Uninstall a NIC Driver

If a new NIC driver does not perform as expected after it has been installed, the driver can be uninstalled, or rolled back, to the previous driver. Double-click the adapter in the Device Manager. In the Adapter Properties window, click the Driver tab, and click Roll Back Driver. If no driver was installed before the update, this option is unavailable. In that case, you need to find a driver for the device and install it manually if the operating system cannot find a suitable driver for the NIC.



Worksheet 8.9.1: Internet Search for NIC Drivers

In this worksheet you research NIC drivers. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this worksheet now or wait until the end of the chapter.

Attach the Computer to an Existing Network

Now that the NIC drivers are installed, you are ready to connect to the network. Plug a network cable, also called an Ethernet patch or straight-through cable, into the network port on the computer. Plug the other end into the network device or wall jack.

After connecting the network cable, look at the LEDs, or link lights, next to the Ethernet port on the NIC to see if any activity is occurring. If no activity is going on, this may indicate a faulty cable, a faulty hub port, or even a faulty NIC. You may have to replace one or more of these devices to correct the problem.

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After you have confirmed that the computer is connected to the network and that the link lights on the NIC indicate a working connection, the computer needs an IP address. Most networks are set up so that the computer receives an IP address automatically from a local DHCP server. If the computer does not have an IP address, you need to enter a unique IP address in the TCP/IP properties of the NIC.

Every NIC must be configured with the following information:

- **Protocols:** The same protocol must be implemented between any two computers that communicate on the same network.
- **IP address:** This address can be configured and must be unique to each device. The IP address can be manually configured or automatically assigned by DHCP.
- ***MAC address*:** Each device has a unique MAC address. The MAC address is assigned by the manufacturer and cannot be changed.

After the computer is connected to the network, you should test connectivity with the **ping** command. Use the **ipconfig** command to find out what your IP address is. Example 8-3 shows sample output from the **ipconfig /all** command.

Example 8-3 ipconfig /all Command

```
C:\> ipconfig /all

Windows IP Configuration

        Host Name . . . . . . . . . . . . : computer
        Primary Dns Suffix  . . . . . . . :
        Node Type . . . . . . . . . . . . : Hybrid
        IP Routing Enabled. . . . . . . . : No
        WINS Proxy Enabled. . . . . . . . : No

Ethernet adapter Local Area Connection:

        Connection-specific DNS Suffix  . :        Description . . . . . . . . :
  Broadcom 440x 10/100 Intergated Controller
        Physical Address. . . . . . . . . : 00-12-3F-E0-59-3D
        Dhcp Enabled. . . . . . . . . . . : Yes
        Autoconfiguration Enabled . . . . : Yes
        IP Address. . . . . . . . . . . . : 192.168.1.112
        Subnet Mask . . . . . . . . . . . : 255.255.255.0
        Default Gateway . . . . . . . . . : 192.168.1.1
        DHCP Server . . . . . . . . . . . : 192.168.1.1
        DNS Servers . . . . . . . . . . . : 192.168.1.1
        Lease Obtained. . . . . . . . . . : Monday, November 05, 2007 5:05:13 PM
        Lease Expires . . . . . . . . . . : Monday, November 12, 2007 5:05:13 PM
```

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Ping your own IP address to make sure that your NIC is working properly. After you have determined that your NIC is working, **ping** your default gateway or another computer on your network, as shown in Example 8-4. A ***default gateway*** allows a host to communicate outside your network. If you have an Internet connection, ping a popular website, such as www.cisco.com. If you can successfully ping an Internet site or another computer on your network, everything is working properly with your connection. If you cannot ping one of these, you need to troubleshoot the connection.

Example 8-4 ping Command

```
C:\> ping 192.168.1.112

Pinging 192.168.1.112 with 32 bytes of data:

Reply from 192.168.1.112: bytes=32 time<1ms TTL=128
Reply from 192.168.1.112: bytes=32 time<1ms TTL=128
Reply from 192.168.1.112: bytes=32 time<1ms TTL=128
Reply from 192.168.1.112: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.1.112:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 0ms, Maximum = 0ms, Average = 0ms
```



Lab 8.9.2: Configure an Ethernet NIC to Use DHCP

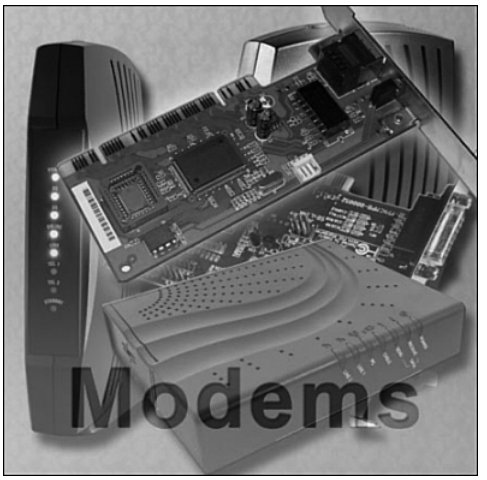
In this lab you configure a NIC to use DHCP from a 300N router. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Describe the Installation of a Modem

A modem, shown in Figure 8-25, is an electronic device that transfers data between one computer and another using analog signals over a telephone line. The modem converts digital data to analog signals for transmission. The modem at the receiving end reconverts the analog signals to digital data to be interpreted by the computer. The process of converting analog signals to digital and back again is called modulation/demodulation. Modem-based transmission is very accurate, despite the fact that telephone lines can be noisy because of clicks, static, and other problems.

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Figure 8-25 Modems



An internal modem plugs into an expansion slot on the motherboard. To configure a modem, jumpers may have to be set to select the IRQ and I/O addresses. No configuration is needed for a "plug-and-play" modem, which can only be installed on a motherboard that supports plug and play. A modem using a serial port that is not yet in use must be configured. Additionally, the software drivers that come with the modem must be installed for the modem to work properly. Drivers for modems are installed the same way drivers are installed for NICs.

External modems connect to a computer through the serial and USB ports.

When computers use the public telephone system to communicate, this is called dialup networking (DUN). Modems communicate with each other using audio tone signals. This means that modems can duplicate the dialing characteristics of a telephone. DUN creates a Point-to-Point Protocol (PPP) connection between two computers over a phone line.

After the line connection has been established, a "handshaking sequence" takes place between the two modems and the computers. The handshaking sequence is a series of short communications that occur between the two systems. This is done to establish the readiness of the two modems and computers to engage in data exchange. Dialup modems send data over the serial telephone line in the form of an analog signal. Because the analog signals change gradually and continuously, they can be drawn as waves. In this system, the digital signals are represented by 1s and 0s. The digital signals must be converted to a waveform to travel across telephone lines. The receiving modem converts them back to digital form, 1s and 0s, so that the receiving computer can process the data.

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AT Commands

All modems require software to control the communication session. Most modem software uses the Hayes-compatible command set. The Hayes command set is based on a group of instructions that always begins with a set of attention (AT) characters, followed by the command characters. These are known as AT commands. Table 8-8 shows the AT command set.

Table 8-8 AT Commands

AT Command	Function
AT	The attention code that precedes all modem action commands
ATP *xxxxxxx*	Dials the phone number, *xxxxxxx*, using pulse dialing
ATDT *xxxxxxx*	Dials the phone number, *xxxxxxx*, using tone dialing
ATA	Answers the phone immediately
ATHO	Hangs up the phone immediately
ATZ	Resets the modem to its power-up settings
ATF	Resets modem parameters and settings to the factory defaults
AT+++	Breaks the signal, changing from data mode to command mode
P	Signifies pulse dialing
T	Signifies tone dialing
W	Indicates that the modem will wait

The AT commands are modem control commands. The AT command set is used to issue dial, hang-up, reset, and other instructions to the modem. Most user manuals that come with a modem contain a complete listing of the AT command set.

The standard Hayes-compatible code to dial is ATD*xxxxxxx*. An AT string usually has no spaces. If a space is inserted, most modems ignore it. The *x* signifies the number dialed. A local call has seven digits, and a long-distance call has 11 digits. A W indicates that the modem will wait for an outside line, if necessary, to establish a tone before proceeding. Sometimes, a T is added to signify tone dialing, or a P is added to signify pulse dialing.

Identify the Names, Purposes, and Characteristics of Other Technologies Used to Establish Connectivity

There are many ways to connect to the Internet. Phone, cable, satellite, and private telecommunications companies offer Internet connections for businesses and home use.

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In the 1990s, the Internet typically was used for data transfer. Transmission speeds were slow compared to the high-speed connections that are available today. Most Internet connections were analog modems that used the plain old telephone system (POTS) to send and receive data. In recent years, many businesses and home users have switched to high-speed Internet connections. The additional bandwidth allows for transmission of voice and video as well as data.

You should understand how users connect to the Internet and the advantages and disadvantages of different connection types.

After completing this section, you will meet these objectives:

- Describe telephone technologies.
- Define power line communication.
- Define broadband.
- Define VOIP.

Describe Telephone Technologies

Several WAN solutions are available for connecting between sites or to the Internet. WAN connection services provide different speeds and levels of service. Before committing to any type of Internet connection, research all the available services to determine the best solution to meet the customer's needs.

Analog Telephone

Analog telephone technology uses standard voice telephone lines. This type of service uses a modem to place a telephone call to another modem at a remote site, such as an ***Internet service provider (ISP)***. Using the phone line with an analog modem has two major disadvantages. The first is that the telephone line cannot be used for voice calls while the modem is in use. The second is the limited bandwidth provided by analog phone service. The maximum bandwidth using an analog modem is 56 Kbps, but in reality, it usually is much lower than that. An analog modem is not a good solution for the demands of busy networks.

Integrated Services Digital Network (ISDN)

The next advancement in WAN service is ISDN. ISDN is a standard for sending voice, video, and data over normal telephone wires. ISDN technology uses the telephone wires as an analog telephone service. However, ISDN uses digital technology to carry the data. Because it uses digital technology, ISDN provides higher-quality voice and higher-speed data transfer than traditional analog telephone service.

ISDN digital connections offer three services: Basic Rate Interface (BRI), Primary Rate Interface (PRI), and Broadband ISDN (BISDN). ISDN uses two different types of

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communication channels. The B channel is used to carry the information—data, voice, or video. The D channel usually is used for controlling and signaling, but it can be used for data.

Here are the types of ISDN:

- **BRI:** ISDN Basic Rate Interface offers a dedicated 128-Kbps connection using two 64-Kbps B channels. ISDN BRI also uses one 16-Kbps D channel for call setup, control, and teardown.
- **PRI:** ISDN Primary Rate Interface offers up to 1.544 Mbps over 23 B channels in North America and Japan or 2.048 Mbps over 30 B channels in Europe and Australia. ISDN PRI also uses one 64-Kbps D channel for call maintenance.
- **BISDN:** Broadband ISDN manages different types of service all at the same time. BISDN is mostly used only in network backbones.

Digital Subscriber Line (DSL)

DSL is an "always-on" technology. This means that you don't need to dial up each time to connect to the Internet. DSL uses the existing copper telephone lines to provide high-speed digital data communication between end users and telephone companies. Unlike ISDN, in which digital data communication replaces analog voice communication, DSL shares the telephone wire with analog signals.

The telephone company limits the bandwidth of the analog voice on the lines. This limit allows the DSL to place digital data on the phone wire in the unused portion of the bandwidth. This sharing of the phone wire allows voice calls to be placed while DSL is connecting to the Internet.

You must consider two major points when selecting DSL. DSL has distance limitations. The phone lines used with DSL were designed to carry analog information. Therefore, the length that the digital signal can be sent is limited, and the signal cannot pass through any form of multiplexer used with analog phone lines. The other consideration is that the voice information and the data carried by DSL must be separated at the customer site. A device called a splitter separates the connection to the phones and the connection to the local network devices.

Asymmetric digital subscriber line (ADSL) is currently the most commonly used DSL technology. ADSL has different bandwidth capabilities in each direction. ADSL has a fast downstream speed—typically 1.5 Mbps. Downstream is the process of transferring data from the server to the end user. This is beneficial to users who download large amounts of data. The high-speed upload rate of ADSL is slower. ADSL does not perform well when hosting a web server or FTP server, both of which involve upload-intensive Internet activities.

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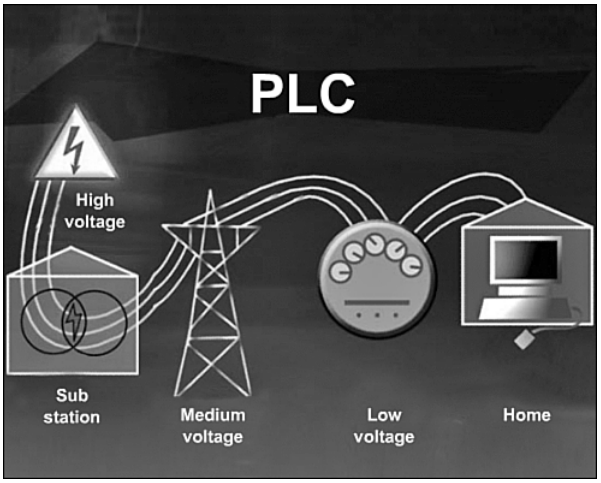
The following are some of the most common DSL types:

- ***ADSL*:** Asymmetric DSL currently is the most common implementation. It has speeds that vary from 384 Kbps to more than 6 Mbps downstream. The upstream speed typically is lower.
- ***HDSL*:** High Data Rate DSL provides equal bandwidth in both directions. It is 1.544 Mbps in North America and 2.048 Mbps in Europe.
- **SDSL:** Symmetric DSL provides the same speed, up to 3 Mbps, for uploads and downloads.
- **VDSL:** Very High Data Rate DSL is capable of bandwidths between 13 and 52 Mbps downstream and 16 Mbps upstream.
- ***IDSL*:** ISDN DSL is actually DSL over ISDN lines. It is a set of CCIT/ITU standards for digital transmission over ordinary telephone copper wire, as well as over other media, with a top speed of 144 Kbps. ISDN is available in areas that do not qualify for other DSL implementations. An ISDN adapter at both the user side and service provider side is required. ISDN generally is available in urban areas in the U.S. and Europe from the local phone company.

Define Power Line Communication

Power line communication (PLC) is a communication method that uses power distribution wires (the local electric grid) to send and receive data, as shown in Figure 8-26.

Figure 8-26 Power Line Communication



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PLC is known by other names:

- Power Line Networking (PLN)
- Mains communication
- Power Line Telecom (PLT)

With PLC, an electric company can superimpose an analog signal over the standard 50- or 60-Hz AC that travels in power lines. The analog signal can carry voice and data signals.

PLC may be available in areas where other high-speed connections are not. PLC is faster than an analog modem and may cost much less than other high-speed connection types. As this technology matures, it will become more common to find and may increase in speed.

You can use PLC to network computers within your home instead of installing network cabling or wireless technology. PLC connections can be used anywhere there is an electrical outlet. You can control lighting and appliances using PLC without installing control wiring.

Define Broadband

Broadband is a technique used to transmit and receive multiple signals using multiple frequencies over one cable. For example, the cable used to bring cable television to your home can carry computer network transmissions at the same time. Because the two transmission types use different frequencies, they do not interfere with each other.

Broadband is a signaling method that uses a wide range of frequencies that can be further divided into channels. In networking, the term broadband describes communication methods that transmit two or more signals at the same time. Sending two or more signals simultaneously increases the rate of transmission. Some common broadband network connections include cable, DSL, ISDN, and satellite.

Cable

A ***cable modem*** connects your computer to the cable company using the same coaxial cable that connects to your cable television. You can plug your computer directly into the cable modem, or you can connect a router, switch, hub, or multipurpose network device so that multiple computers can share the connection to the Internet.

DSL

With DSL, the voice and data signals are carried on different frequencies on the copper telephone wires. A filter is used to prevent DSL signals from interfering with phone signals. Plug the filter into a phone jack, and plug the phone into the filter.

The DSL modem does not require a filter. The DSL modem is unaffected by the telephone frequencies. Like a cable modem, a DSL modem can connect directly to your computer, or

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it can be connected to a networking device to share the Internet connection with multiple computers.

ISDN

ISDN is another example of broadband. ISDN uses multiple channels and can carry different types of services; therefore, it is considered a type of broadband. ISDN can carry voice, video, and data.

Satellite

Broadband satellite is an alternative for customers who cannot get cable or DSL connections. A satellite connection does not require a phone line or cable; it uses a satellite dish for two-way communication. Download speeds typically are up to 500 Kbps; uploads are closer to 56 Kbps. It takes time for the signal from the satellite dish to be relayed to your ISP through the satellite orbiting the Earth.

People who live in rural areas often use satellite broadband because they need a faster connection than dialup, and no other broadband connection is available.



Worksheet 8.10.3: Answer Broadband Questions

In this worksheet you identify the different types of broadband. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this worksheet now or wait until the end of the chapter.

Define VoIP

Voice over IP (VoIP) is a method to carry telephone calls over the data networks and Internet. VoIP converts the analog signals of our voices into digital information that is transported in IP packets. VoIP can also use an existing IP network to provide access to the public switched telephone network (PSTN).

When using VoIP, you are dependent on an Internet connection. This can be a disadvantage if the Internet connection experiences an interruption in service. When a service interruption occurs, the user cannot make phone calls.

Figure 8-27 shows some examples of VoIP phones.

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Figure 8-27 VoIP Phones



Identify and Apply Common Preventive Maintenance Techniques Used for Networks

Certain common preventive maintenance techniques should continually be performed for a network to operate properly. If an organization has one malfunctioning computer, generally only one user is affected. But if the network is malfunctioning, many or all users will be unable to work.

One of the biggest problems with network devices, especially in the server room, is heat. Network devices, such as computers, hubs, and switches, do not perform well when they overheat. Often, excess heat is generated by accumulated dust and dirty air filters. When dust gathers in and on network devices, it impedes the flow of cool air and sometimes even clogs fans. It is important to keep network rooms clean and to change air filters often. It is also a good idea to have replacement filters available for prompt maintenance.

Preventive maintenance involves checking a network's various components for wear. Check the condition of network cables, because they are often moved, unplugged, and kicked. Many network problems can be traced to a faulty cable. You should replace any cables that have exposed wires, that are badly twisted, or that are bent.

Label your cables. This practice will save troubleshooting time later. Refer to wiring diagrams, and always follow your company's cable-labeling guidelines.

Troubleshoot a Network

Network issues can be simple or complex. To assess how complicated the problem is, you should determine how many computers on the network are experiencing the problem.

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If there is a problem with one computer on the network, start the troubleshooting process at that computer. If there is a problem with all computers on the network, start the troubleshooting process in the network room where all computers are connected. As a technician, you should develop a logical and consistent method for diagnosing network problems by eliminating one problem at a time.

Follow the steps outlined in this section to accurately identify, repair, and document the problem. The troubleshooting process is as follows:



Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

After completing this section, you will meet these objectives:

- Review the troubleshooting process.
- Identify common network problems and solutions.

Review the Troubleshooting Process

Network problems can result from a combination of hardware, software, and connectivity issues. Computer technicians must be able to analyze the problem and determine the cause of the error to repair the network issue. This process is called troubleshooting.

The first step in the troubleshooting process is to gather data from the customer. Here are some open-ended questions to ask the customer:

- What problems are you experiencing with your computer or network?
- What software has been installed on your computer recently?
- What were you doing when the problem was identified?
- What error messages have you received on your computer?
- What type of network connection is the computer using?

Here are some closed-ended questions to ask the customer:

- Has anyone else used your computer recently?
- Can you see any shared files or printers?
- Have you changed your password recently?

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- Can you access the Internet?
- Are you currently logged into the network?

After you have talked to the customer, you should verify the obvious issues for networks:

- Loose cable connections
- Improperly installed NIC
- Check the NIC link lights
- Low wireless signal strength
- Invalid IP address

After you have checked the obvious issues, try some quick solutions for networks:

- Check that all cables are connected to the proper locations.
- Unseat and then reconnect cables and connectors.
- Reboot the computer or network device.
- Log in as a different user.
- Repair or reenable the network connection.
- Contact the network administrator.

If quick solutions do not correct the problem, it is time to gather data from the computer. Here are some different ways to gather information about the problem from the network:

- Ping is used to check network connectivity. It sends a packet to the specified address and waits for a reply.
- Nslookup is used to query Internet domain name servers. It returns a list of hosts in a domain or the information for one host.
- Tracert is used to determine the route taken by packets when they travel across the network. It shows where communications between your computer and another computer are having difficulty.
- Net View displays a list of computers in a workgroup. It shows the available shared resources on a network.

At this point, you have enough information to evaluate the problem and then research and implement possible solutions. Here are some resources for possible solutions:

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups

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- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

After you have solved the network problem, you close with the customer. Here are some of the tasks required to complete this step:

- Discuss the solution implemented with the customer.
- Have the customer verify that the problem has been solved.
- Provide the customer with all the paperwork.
- Document the steps taken to solve the problem in the work order and the technician's journal.
- Document any components used in the repair.
- Document the time spent to resolve the problem.

Identify Common Network Problems and Solutions

Network problems can be attributed to hardware, software, connectivity issues, or some combination of the three. You will resolve some types of network problems more often than others. Table 8-9 is a chart of common network problems and solutions.

Table 8-9 Common Problems and Solutions

Problem Symptom	Possible Solution
The computer can't connect to a popular website.	Check DNS settings, hardware, and software firewall settings.
The computer has an IP address of 169.254.x.x.	Check to make sure that the DHCP server is operational and can be pinged.
The computer can't connect to the network.	Check for loose network cables.
The computer can't print using the network printer.	Check user permissions and the status of the network printer.



Worksheet 8.12.2: Diagnose a Network Problem

In this worksheet you diagnose a network problem. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this worksheet now or wait until the end of the chapter.

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Summary

This chapter introduced you to the fundamentals of networking, the benefits of having a network, and the ways to connect computers to a network. The different aspects of troubleshooting a network were discussed, with examples of how to analyze and implement simple solutions. The following concepts from this chapter are important to remember:

- A computer network is composed of two or more computers that share data and resources.
- A local-area network (LAN) is a group of interconnected computers that are under the same administrative control.
- A wide-area network (WAN) connects LANs in geographically separated locations.
- In a peer-to-peer network, devices are connected directly to each other. A peer-to-peer network is easy to install, and no additional equipment or dedicated administrator is required.
- The network topology defines how computers, printers, and other devices are connected. The physical topology describes the layout of the wire and devices, as well as the paths used by data transmissions. The logical topology is the path that signals travel from one point to another. Topologies include bus, star, ring, and mesh.
- Networking media can be defined as the means by which signals, or data, are sent from one computer to another. Signals can be transmitted by either cable or wireless means. The media types discussed were coaxial cable, twisted-pair cable, fiber-optic cable, and radio frequencies.
- Ethernet architecture is currently the most popular type of LAN architecture.
- The OSI reference model is an industry-standard framework that is used to divide networking functions into seven distinct layers: application, presentation, session, transport, network, data link, and physical. It is important to understand the purpose of each layer.
- The TCP/IP suite of protocols has become the dominant standard for the Internet.
- A NIC is a device that plugs into a motherboard and provides ports for the network cable connections. It is the computer interface with the LAN.
- The three transmission methods for sending signals over data channels are simplex, half duplex, and full duplex. Full-duplex networking technology increases performance because data can be sent and received at the same time. DSL, two-way cable modem, and other broadband technologies operate in full-duplex mode.
- It is important to clean equipment regularly and to use a proactive approach to prevent problems.

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- When troubleshooting network problems, listen to what your customer tells you so that you can formulate open-ended and closed-ended questions that will help you determine where to begin fixing the problem. Verify obvious issues, and try quick solutions before escalating the troubleshooting process.

Summary of Exercises

This is a summary of the labs and worksheets associated with this chapter.



Lab

The following lab covers material from this chapter. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Lab 8.9.2: Configure an Ethernet NIC to Use DHCP



Worksheets

The following worksheets cover material from this chapter. Refer to the worksheets in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Worksheet 8.3.2: Identify IP Address Classes

Worksheet 8.9.1: Internet Search for NIC Drivers

Worksheet 8.10.3: Answer Broadband Questions

Worksheet 8.12.2: Diagnose a Network Problem

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. The Internet is an example of which type of network?

   A. LAN
   B. SAN
   C. WAN
   D. WLAN

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2. What is the suggested maximum number of PCs in a peer-to-peer network?

   A. 10
   B. 25
   C. 50
   D. 100

3. Which method of data transfer allows information to be sent and received at the same time?

   A. Full duplex
   B. Half duplex
   C. Multiplex
   D. Simplex

4. Which dotted-decimal number is used to distinguish the network portion of the IP address from the host portion?

   A. Default gateway
   B. MAC address
   C. Physical address
   D. Subnet mask

5. Which suite of protocols is used to transmit data across the Internet?

   A. AppleTalk
   B. ARP
   C. DNS
   D. IPX/SPX
   E. TCP/IP

6. Which cable type is a common choice for use on Ethernet networks?

   A. Thick coaxial
   B. Thin coaxial
   C. STP
   D. UTP

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7. Which networking protocol translates a network name such as www.cisco.com into a unique IP address?

   A. APIPA
   B. ARP
   C. DHCP
   D. DNS
   E. Proxy ARP

8. Which protocol maps known IP addresses to MAC addresses on a local network?

   A. ARP
   B. DHCP
   C. FTP
   D. RARP

9. A technician wants to update the NIC driver for a computer. What is the best way to find new drivers for the NIC?

   A. Installation media that came with the NIC
   B. Windows Update
   C. The website for the manufacturer of the NIC
   D. The Microsoft website

10. What is the most commonly used DSL technology?

   A. ADSL
   B. HDSL
   C. IDSL
   D. SDSL
   E. VDSL

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CHAPTER 9

Fundamental Security

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- Why is security important?
- What are security threats?
- What are some security procedures?
- What are the preventive maintenance techniques for security?
- What can be done to troubleshoot security?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

malicious threat *page xx*

accidental threat *page xx*

virus *page xx*

worm *page xx*

Trojan horse *page xx*

virus protection software *page xx*

antivirus software *page xx*

security policy *page xx*

web security *page xx*

ActiveX *page xx*

Java *page xx*

JavaScript *page xx*

adware *page xx*

grayware *page xx*

malware *page xx*

spyware *page xx*

social engineering *page xx*

denial of service (DoS) *page xx*

ping of death *page xx*

e-mail bomb *page xx*

distributed DoS (DDoS) *page xx*

spam *page xx*

popup *page xx*

SYN flood *page xx*

spoofing *page xx*

replay *page xx*

DNS poisoning *page xx*

card key *page xx*

biometric *page xx*

password protection *page xx*

data encryption *page xx*

port protection *page xx*

continues

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continued

data backup *page xx*

file system security *page xx*

Wired Equivalent Privacy (WEP) *page xx*

Wi-Fi Protected Access (WPA) *page xx*

Lightweight Extensible Authentication Protocol (LEAP) *page xx*

Wireless Transport Layer Security (WTLS) *page xx*

signature file *page xx*

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Technicians need to understand computer and network security. Failure to implement proper security procedures can affect users, computers, and the general public. Private information, company secrets, financial data, computer equipment, and items of national security are placed at risk if proper security procedures are not followed.

Explain Why Security Is Important

Computer and network security help keep data and equipment safe by giving only the appropriate people access. Everyone in an organization should give high priority to security, because everyone can be affected by a lapse in security.

Theft, loss, network intrusion, and physical damage are some of the ways a network or computer can be harmed. Damage or loss of equipment can mean a loss of productivity. Repairing and replacing equipment can cost the company time and money. Unauthorized use of a network can expose confidential information and reduce network resources.

An attack that intentionally degrades the performance of a computer or network can also harm an organization's production. Poorly implemented security measures that allow unauthorized access to wireless network devices demonstrate that physical connectivity is not necessary for security breaches by intruders.

A technician's primary responsibilities include data and network security. A customer or an organization may depend on you to ensure that their data and computer equipment are secure. You will perform tasks that are more sensitive than those assigned to the average employee. You may have to repair, adjust, and install equipment. You need to know how to configure settings to keep the network secure, but still keep it available to those who need to access it. You will ensure that software patches and updates are applied, antivirus software is installed, and antispyware software is used. You may also be asked to instruct users on how to maintain good security practices with computer equipment.



Worksheet 9.1.0: Security Attacks

In this activity, you use the Internet, a newspaper, or magazines to gather information to help you become familiar with computer crime and security attacks in your area. Be prepared to discuss your research with the class. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

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Describe Security Threats

To successfully protect computers and the network, a technician must understand both of the following types of threats to computer security:

- **Physical:** Events or attacks that steal, damage, or destroy such equipment as servers, switches, and wiring.
- **Data:** Events or attacks that remove, corrupt, deny access to, allow access to, or steal information.

Threats to security can come from inside or outside an organization, and the level of potential damage can vary greatly. Potential threats include the following:

- **Internal:** Employees who have access to data, equipment, and the network. Internal attacks can be characterized as follows:
  - ***Malicious threats*** are when an employee intends to cause damage.
  - ***Accidental threats*** are when the user damages data or equipment unintentionally.
- **External:** Users outside an organization who do not have authorized access to the network or resources. External attacks can be characterized as follows:
  - Unstructured attacks, which use available resources, such as passwords or scripts, to gain access to and run programs designed to vandalize.
  - Structured attacks, which use code to access operating systems and software.

Physical loss or damage to equipment can be expensive, and data loss can be detrimental to your business and reputation. Threats against data are constantly changing as attackers find new ways to gain entry and commit their crimes.

After completing this section, you will meet these objectives:

- Define viruses, worms, and Trojan horses.
- Explain web security.
- Define adware, spyware, and grayware.
- Explain denial of service.
- Describe spam and popups.
- Explain social engineering.
- Explain TCP/IP attacks.
- Explain hardware deconstruction and recycling.

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Define Viruses, Worms, and Trojan Horses

Computer viruses are created with malicious intent and sent by attackers. A ***virus*** is attached to small pieces of computer code, software, or documents. The virus executes when the software is run on a computer. If the virus spreads to other computers, those computers could continue to spread the virus.

A virus is transferred to another computer through e-mail, file transfers, and instant messaging. The virus hides by attaching itself to a file on the computer. When the file is accessed, the virus executes and infects the computer. A virus has the potential to corrupt or even delete files on your computer, use your e-mail to spread itself to other computers, or even erase your hard drive.

Some viruses can be exceptionally dangerous. The most damaging type of virus is used to record keystrokes. Attackers can use these viruses to harvest sensitive information, such as passwords and credit card numbers. Viruses may even alter or destroy information on a computer. Stealth viruses can infect a computer and lay dormant until summoned by the attacker.

A ***worm*** is a self-replicating program that is harmful to networks. A worm uses the network to duplicate its code to the hosts on a network, often without any user intervention. It is different from a virus because a worm does not need to attach to a program to infect a host. Even if the worm does not damage data or applications on the hosts it infects, it harms networks because it consumes bandwidth.

A ***Trojan horse*** technically is a worm. It does not need to be attached to other software. Instead, a Trojan threat is hidden in software that appears to do one thing, and yet behind the scenes it does another. Trojans often are disguised as useful software. The Trojan program can reproduce like a virus and spread to other computers. Computer data damage and production loss could be significant. A technician may be needed to perform the repairs, and employees may lose or have to replace data. An infected computer could be sending critical data to competitors while at the same time infecting other computers on the network.

Virus protection software, known as ***antivirus software***, is software designed to detect, disable, and remove viruses, worms, and Trojans before they infect a computer. Antivirus software becomes outdated quickly, however. The technician is responsible for applying the most recent updates, patches, and virus definitions as part of a regular maintenance schedule. Many organizations establish a written ***security policy*** stating that employees are not permitted to install any software that is not provided by the company. Organizations also make employees aware of the dangers of opening e-mail attachments that may contain a virus or worm.

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Worksheet 9.2.1: Third-Party Antivirus Software

In this activity, you use the Internet, a newspaper, or a local store to gather information about third-party antivirus software. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

Explain Web Security

Web security is important because so many people visit the World Wide Web every day. Some of the features that make the web useful and entertaining can also make it harmful to a computer.

Tools that are used to make web pages more powerful and versatile can also make computers more vulnerable to attacks. Here are some examples of web tools:

- ***ActiveX*** is technology created by Microsoft to control interactivity on web pages. If ActiveX is on a page, the user must download an applet or small program to gain access to the full functionality.
- ***Java*** is a programming language that allows applets to run within a web browser. Examples of applets include a calculator and a counter.
- ***JavaScript*** is a programming language developed to interact with HTML source code to allow interactive websites. Examples include a rotating banner and a popup window.

Attackers can use any of these tools to install a program on a computer. To protect against these attacks, most browsers have settings that force the computer user to authorize the downloading or use of ActiveX, Java, and JavaScript.

Define Adware, Spyware, and Grayware

Adware, spyware, and grayware are usually installed on a computer without the user's knowledge. These programs collect information stored on the computer, change the computer configuration, or open extra windows on the computer without the user's consent.

Adware is a software program that displays advertising on your computer. Adware is usually distributed with downloaded software. Most often, adware is displayed in a popup window. Adware popup windows are sometimes difficult to control; they open new windows faster than users can close them.

Grayware or ***malware*** is a file or program other than a virus that is potentially harmful. Many grayware attacks are phishing attacks, which try to persuade the user to unknowingly give attackers access to personal information. As you fill out an online form, the data is sent to the attacker. Grayware can be removed using spyware and adware removal tools.

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Spyware, a type of grayware, is similar to adware. It is distributed without any user intervention or knowledge. After it is installed, the spyware monitors activity on the computer. The spyware then sends this information to the organization responsible for launching the spyware.

Phishing is a form of ***social engineering***, in which the attacker pretends to represent a legitimate outside organization, such as a bank. A potential victim is contacted via e-mail. The attacker might ask for verification of information, such as a password or username, to supposedly prevent some terrible consequence from occurring.

Note

There is rarely a need to give out sensitive personal or financial information online. Be suspicious. Use the postal service to share sensitive information.

Explain Denial of Service

Denial of service (DoS) is a form of attack that prevents users from accessing normal services, such as e-mail or a web server. DoS works by sending so many requests for a system resource that the requested service is overloaded and ceases to operate.

DoS attacks can affect servers and computers in the following ways:

- ***Ping of death*** is a series of repeated, larger-than-normal pings that are intended to crash the receiving computer.
- An ***e-mail bomb*** is a large quantity of bulk e-mail sent to individuals, lists, or domains, intending to prevent users from accessing e-mail.

Distributed DoS (DDoS) is another form of attack that uses many infected computers, called zombies, to launch an attack. With DDoS, the intent is to obstruct or overwhelm access to the targeted server. Zombie computers located at different geographic locations make it difficult to trace the origin of the attack.

Describe Spam and Popup Windows

Spam, also known as junk mail, is unsolicited e-mail. In most cases, spam is used for advertising. However, spam can be used to send harmful links or deceptive content.

When used as an attack method, spam might include links to an infected website or an attachment that could infect a computer. These links or attachments might generate lots of windows (called ***popups***) designed to capture your attention and lead you to advertising sites. Uncontrolled popup windows can quickly cover your screen and prevent you from getting any work done.

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Many antivirus and e-mail software programs automatically detect and remove spam from an e-mail inbox. Some spam still may get through, so you should look for some of the more common indications:

- No subject line
- An incomplete return addresses
- Computer-generated e-mails
- Return e-mails not sent by the user

Explain Social Engineering

A social engineer is a person who gains access to equipment or a network by tricking people into providing the necessary information. Often, the social engineer gains the confidence of an employee and convinces that person to divulge username and password information.

A social engineer may pose as a technician to try to gain entry into a facility. When he is inside, he may look over employees' shoulders to gather information, seek out papers on desks with passwords and phone extensions, or obtain a company directory with e-mail addresses.

The following are some basic precautions to help protect against social engineering:

- Never give out your password.
- Always ask for the ID of unknown persons.
- Restrict the access of unexpected visitors.
- Escort all visitors.
- Never post your password in your work area.
- Log off or lock your computer when you leave your desk.
- Do not let anyone follow you through a door that requires an access card.

Explain TCP/IP Attacks

TCP/IP is the protocol suite that is used to control all the communications on the Internet. Unfortunately, TCP/IP can also make a network available to attackers through the use of the following common types of attacks:

- A ***SYN flood*** randomly opens TCP ports, tying up network equipment or a computer with a large number of false requests, causing sessions to be denied to others.
- **DoS** attempts to make a computer resource unavailable to its intended users.

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- **DDoS** is a DoS attack that uses "zombies" to make tracing the origin of the attack difficult.
- ***Spoofing*** is a method of gaining access to resources on devices by pretending to be a trusted computer.
- **Man-in-the-middle** intercepts or inserts false information in traffic between two hosts.
- ***Replay*** uses network sniffers to extract usernames and passwords to be used later to gain access.
- ***DNS poisoning*** changes the DNS records on a system to point to false servers where the data is recorded.

Explain Hardware Deconstruction and Recycling

Hardware deconstruction is the process of removing sensitive data from hardware and software before recycling or discarding them. Hard drives should be erased to prevent someone from recovering the data using specialized software. It is not enough to delete files or even format the drive. Use a third-party tool to overwrite data multiple times, rendering the data unusable. The only way to be certain that data cannot be recovered from a hard drive is to carefully shatter the platters with a hammer and safely dispose of the pieces.

Media such as CDs and floppy disks must also be destroyed. Use a shredding machine that is designed for this purpose.

Identify Security Procedures

You should use a security plan to determine what will be done in a critical situation. Security plan policies should be constantly updated to reflect the latest threats to a network. A security plan with clear security procedures is the basis for a technician to follow. Security plans should be reviewed each year.

Part of the process of ensuring security is conducting tests to determine areas where security is weak. Testing should be done on a regular basis. New threats are released daily. Regular testing provides details of any possible weaknesses in the current security plan that should be addressed.

A network has multiple layers of security, as shown in Figure 9-1, including physical, wireless, and data. Each layer is subject to security attacks. The technician needs to understand how to implement security procedures to protect equipment and data.

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Figure 9-1 Security Pyramid



After completing this section, you will meet these objectives:

- Explain what is required in a basic local security policy.
- Explain the tasks required to protect physical equipment.
- Describe ways to protect data.
- Describe wireless security techniques.

Explain What Is Required in a Basic Local Security Policy

Although local security policies may vary between organizations, all organizations should ask the following questions:

- What assets require protection?
- What are the possible threats?
- What should be done in the event of a security breach?

A security policy should describe how a company defines security issues:

- A process for handling network security incidents
- A process for auditing existing network security
- A general security framework for implementing network security
- Behaviors that are allowed
- Behaviors that are prohibited

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- What to log and how to store the logs: Event Viewer, system log files, or security log files
- Network access to resources through account permissions
- Authentication technologies (such as usernames, passwords, biometrics, and smart cards) to access data

Explain the Tasks Required to Protect Physical Equipment

Physical security is as important as data security. When a computer is stolen, the data is also stolen.

There are several ways to physically protect computer equipment:

- Control access to facilities.
- Use cable locks with equipment, as shown in Figure 9-2.
- Keep telecommunication rooms locked.
- Fit equipment with security screws, as shown in Figure 9-2.
- Use security cages around equipment, as shown in Figure 9-3.
- Label and install sensors, such as Radio Frequency Identification (RFID) tags, on equipment.

Figure 9-2 Physical Security



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Figure 9-3 Locking Devices



For access to facilities, there are several means of protection:

- ***Card keys*** that store user data, including level of access
- ***Biometric*** sensors that identify the user's physical characteristics, such as fingerprints or retinas
- Posted security guard
- Sensors, such as RFID tags, to monitor equipment

Describe Ways to Protect Data

The value of physical equipment is often far less than the value of the data it contains. The loss of sensitive data to a company's competitors or to criminals may be costly. Such losses may result in a lack of confidence in the company and the dismissal of computer technicians in charge of computer security. To protect data, you can implement several methods of security protection, as described in the following sections.

Password Protection

Password protection can prevent unauthorized access to content, as shown in Figure 9-4. To keep attackers from gaining access to data, all computers should be password-protected. Two levels of password protection are recommended:

- **BIOS** prevents BIOS settings from being changed without the appropriate password.
- **Login** prevents unauthorized access to the network.

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Figure 9-4 Secured Connection



Network logins provide a means of logging activity on the network and either preventing or allowing access to resources. This makes it possible to determine what resources are being accessed. Usually, the system administrator defines a naming convention for the usernames when creating network logins. A common example of a username is the person's first initial and last name. You should keep the username naming convention simple so that people do not have a hard time remembering it.

When passwords are assigned, the level of password control should match the level of protection required. A good security policy should be strictly enforced and should include, but not be limited to, the following rules:

- Passwords should expire after a specific period of time.
- Passwords should contain a mixture of numbers, special characters, and uppercase and lowercase letters so that they cannot easily be broken. They should have a minimum of eight characters.
- Users should not write down passwords and leave them where anyone can find them.
- Rules about password expiration and lockout should be defined. Lockout rules apply when an unsuccessful attempt has been made to access the system or when a specific change has been detected in the system configuration.

To simplify the process of administering security, it is common to assign users to groups and then assign groups to resources. This allows you to easily change the access level of users on a network by assigning the users to or removing them from various groups. This is useful when setting up temporary accounts for visiting workers or consultants, giving you the ability to limit access to resources.

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Data Encryption

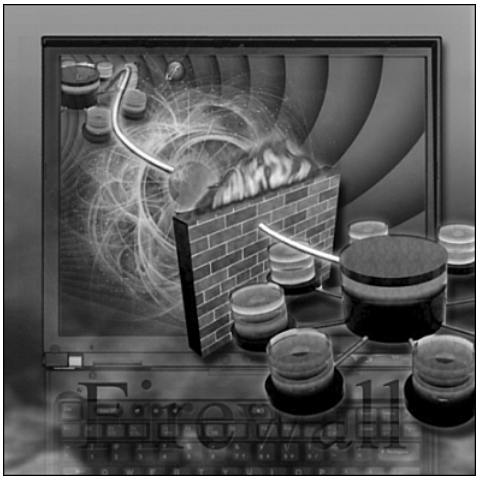
Encrypting data involves using codes and ciphers. ***Data encryption*** can help prevent attackers from monitoring or recording traffic between resources and computers. It may not be possible to decipher captured data in time to make any use of it. A security alert may inform you that you are using an encrypted connection.

A virtual private network (VPN) is an encryption system that protects data as though it resides on a private network. The data actually travels over the Internet or another unsecured public network.

Port Protection

Every communication using TCP/IP is associated with a port number. HTTPS, for instance, by default uses port 443. A firewall, as illustrated in Figure 9-5, is a way of protecting a computer from intrusion through the ports.

Figure 9-5 Firewall



With ***port protection***, the user can control the type of data sent to a computer by selecting which ports will be open and which will be secured. Data being transported on a network is called *traffic*. Table 9-1 shows the ports and protocols associated with the more common types of traffic.

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Table 9-1 Ports and Protocols

Port	Protocol
20	File Transfer Protocol (FTP) data
21	FTP
25	Simple Mail Transfer Protocol (SMTP)
53	Domain Name System (DNS)
80	Hypertext Transfer Protocol (HTTP)

Data Backups

You should include data backup procedures in a security plan. Data can be lost or damaged in circumstances such as theft or equipment failure, or in a disaster, such as a fire or flood. Backing up data is one of the most effective ways of protecting against data loss. Here are some considerations for ***data backups***:

- **Frequency of backups:** Backups can take a long time. Sometimes it is easier to make a full backup monthly or weekly and then do frequent partial backups of any data that has changed since the last full backup. However, spreading the backups over many recordings increases the amount of time needed to restore the data.
- **Storing backups:** Backups should be transported to an approved offsite storage location for extra security. The current backup medium is transported to the offsite location on a daily, weekly, or monthly rotation, as required by the local organization.
- **Security of backups:** Backups can be protected with passwords. These passwords have to be entered before the data on the backup media can be restored.

File System Security

All file systems keep track of resources, but only file systems with journals can log access by user, date, and time. FAT32, which is used in some versions of the Windows file system, lacks both journaling and encryption capabilities. As a result, situations that require good security are usually deployed using a file system such as NTFS, which is part of Windows 2000 and Windows XP. When increased ***file system security*** is needed, it is possible to run certain utilities, such as CONVERT, to upgrade a FAT32 file system to NTFS. The conversion process is not reversible. It is important to define your goals clearly before making the transition. Table 9-2 compares the FAT32 and NTFS file systems.

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Table 9-2 FAT32 and NTFS Comparison

	FAT32	NTFS
Security	Little security	File- and folder-level permissions, encryption
Compatibility	Compatible with Windows 95/98/Me. Can be read/written to by Linux users as well.	Compatible only with Windows (NT, XP, Vista). Linux/UNIX read-only.
File Size	Limit of 4-GB files/32-GB volumes	Limit of 16-terabyte files/256-terabyte volumes
Files Per Volume	4.17 million	4.29 billion (4,294,967,295)
File Size Efficiency	Large clusters waste some space.	Smaller clusters use more of the available space. Built-in compression maximizes space.
Reliability	File allocation tables (FAT) are nonjournaling (do not record file transfer history for use in reconstruction after errors).	New Technology File System (NTFS) includes journaling to rebuild after errors.

Describe Wireless Security Techniques

Traffic flows through radio waves in wireless networks, so it is easy for attackers to monitor and attack data without having to connect to a network physically. Attackers gain access to a network by being within range of an unprotected wireless network. A technician needs to know how to configure access points and wireless network interface cards (WNIC) to an appropriate level of security.

When installing wireless services, you should apply the following wireless security techniques immediately to prevent unwanted access to the network:

- ***Wired Equivalent Privacy (WEP)*** was the first-generation security standard for wireless. Attackers quickly discovered that 64-bit WEP encryption was easy to break. Monitoring programs could detect the encryption keys used to encode the messages. After the keys were obtained, messages could be easily decoded. In an attempt to overcome this weakness, most users employ a 128-bit key for WEP.
- Change the default administration password.

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- Disable the broadcasting of the Service Set Identifier (SSID) to hide it from other users.
- Use MAC filtering to protect the network from other users.
- Change the default values of the SSID by entering the setup program for the access point and renaming the SSID.
- Update to the latest available firmware.
- Install or activate a firewall, and adjust the settings to eliminate all traffic except the desired network settings.
- Update to the latest available firmware.
- Install or activate a firewall, and adjust the settings to eliminate all traffic except the desired network settings.

An attacker can access data as it travels over the radio signal. However, you can use a wireless encryption system to encode data and thereby prevent unwanted capture and use of the data. Both ends of every link must use the same encryption standard. The following list describes the different levels of wireless security, from most secure to least secure:

- ***Lightweight Extensible Authentication Protocol (LEAP)*:** Also called EAP-Cisco, LEAP is a wireless security protocol created by Cisco to address the weaknesses in WEP and WPA. LEAP is a good choice when using Cisco equipment in conjunction with operating systems such as Windows and Linux.
- ***Wi-Fi Protected Access (WPA)*:** An improved version of WEP. It was created as a temporary solution until 802.11i (a security layer for wireless systems) was fully implemented. Now that 802.11i has been ratified, WPA2 has been released. It covers the entire 802.11i standard.
- **WEP 128:** An enhanced encryption protocol combining a 104-bit key and a 24-bit initialization vector.
- **WEP 64:** The first-generation security standard for wireless. It could be exploited because of an encryption key that was vulnerable to decoding.
- **No security:** Although you can elect to implement no security whatsoever, you leave your wireless network completely vulnerable to attack.

In addition, ***Wireless Transport Layer Security (WTLS)*** is a security layer used in mobile devices that employ the Wireless Applications Protocol (WAP). Mobile devices do not have a great deal of spare bandwidth to devote to security protocols. WTLS was designed to provide security for WAP devices in a bandwidth-efficient manner.

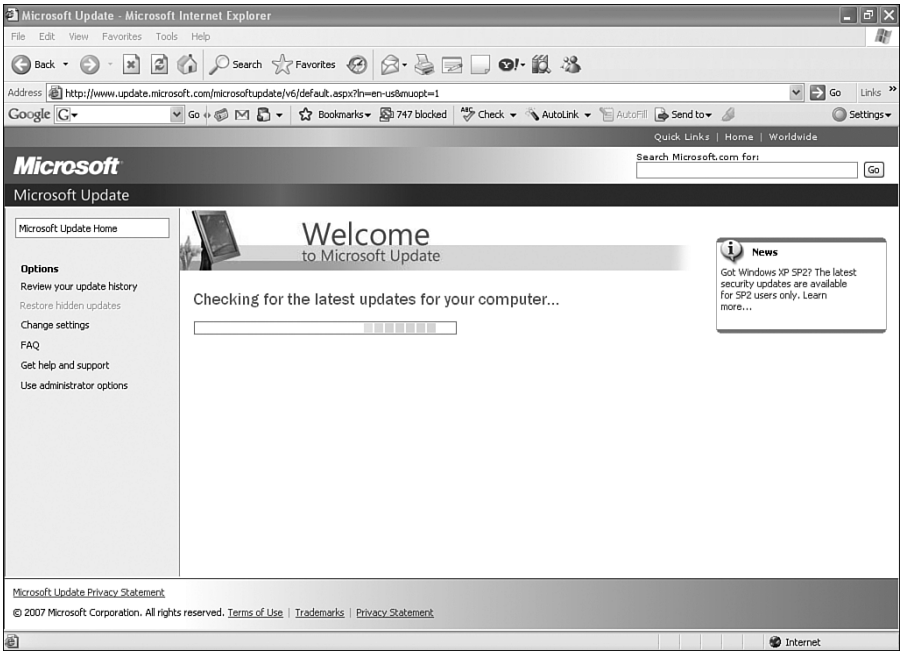
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Identify Common Preventive Maintenance Techniques for Security

Regular security updates are essential to meet the threat from attackers constantly searching for new ways of breaching security. Software manufacturers have to regularly create and issue new patches to fix flaws and vulnerabilities in products. If a technician leaves a computer unprotected, an attacker can easily gain access. Unprotected computers on the Internet may become infected within a few minutes.

Because of the constantly changing security threats, a technician should understand how to install patches and updates, as shown in Figure 9-6. They should also be able to recognize when new updates and patches are available. Some manufacturers release updates on the same day every month and also send out critical updates when necessary. Other manufacturers provide automatic update services that patch the software every time a computer is turned on. Manufacturers also often send e-mail notifications when a new patch or update is released.

Figure 9-6 Security Updates



At the end of this section, you will meet these objectives:

- Explain how to update signature files for virus checkers and spyware.
- Explain how to install operating system service packs and security patches.

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Explain How to Update Signature Files for Virus Checkers and Spyware

Threats to security from viruses and worms are always present. Attackers constantly look for new ways to infiltrate computers and networks. Because new viruses are always being developed, security software must be continually updated. This process can be performed automatically, but a technician should know how to manually update any type of protection software and all customer application programs.

Virus, spyware, and adware detection programs look for patterns in the programming code of the software in a computer. These patterns are determined by analyzing viruses that are intercepted on the Internet and on local-area networks (LAN). These code patterns are called signatures. The publishers of protection software compile the signatures into virus definition tables. To update ***signature files*** for antivirus and antispyware software, first check to see if the signature files are the most recent ones. You can do this by navigating to the **About** option of the protection software or by launching the update tool for the protection software. If the signature files are out of date, update them manually with the **Update Now** option available on most protection software.

You should always retrieve the signature files from the manufacturer's website. However, to avoid creating too much traffic at a single site, some manufacturers distribute the signature files for download to multiple download sites. These download sites are called mirrors.

To update a signature file, follow these steps:



Step 1. Set the Windows restore point.

Step 2. Open the antivirus or antispyware program.

Step 3. Locate the update control button, and select it.

Step 4. After the program is updated, use it to scan your computer.

Step 5. When the scan is complete, check the report for viruses or other problems that could not be treated, and delete them yourself.

Step 6. Set the antivirus or antispyware program to automatically update and to run on a scheduled basis.

Caution

When downloading the signature files from a mirror, ensure that the mirror site is legitimate. Always link to the mirror site from the manufacturer's website.

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Explain How to Install Operating System Service Packs and Security Patches

Viruses and worms can be difficult to remove from a computer. Software tools are required to remove viruses and repair the computer code that the virus has modified. These software tools are provided by operating system manufacturers and security software companies. Make sure that you download these tools from a legitimate site.

Manufacturers of operating systems and software applications may provide code updates called patches that prevent a newly discovered virus or worm from making a successful attack. From time to time, manufacturers combine patches and upgrades into a comprehensive update application called a service pack. Many infamous and devastating virus attacks could have been much less severe if more users had downloaded and installed the latest service pack.

The Windows operating system routinely checks the Windows Update website for high-priority updates that can help protect a computer from the latest security threat. These updates can include security updates, critical updates, and service packs. Depending on the setting you choose, Windows automatically downloads and installs any high-priority updates that your computer needs, or notifies you as these updates become available.

Updates must be installed, not just downloaded. If you use the Automatic setting, you can schedule the time and day. Otherwise, new updates are installed at 3 a.m. by default. If your computer is turned off during a scheduled update, updates are installed the next time you start your computer. You can also choose to have Windows notify you when a new update is available and install the update yourself.

To update the operating system with a service pack or security patch, follow these steps:



Step 1. Create a restore point in case of a problem with the update.

Step 2. Check the updates to ensure that you have the latest ones.

Step 3. Download the updates using Automatic Updates or from the operating system manufacturer's website.

Step 4. Install the update.

Step 5. Restart if required.

Step 6. Test all aspects to ensure that the update has not caused any issues.



Worksheet 9.4.2: Operating System Updates

In this activity, you use the Internet to research operating system updates. Be prepared to discuss your research with the class. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

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Troubleshoot Security

The troubleshooting process is used to help resolve security issues. These problems range from simple, such as preventing someone from watching over your shoulder, to more complex problems, such as manually removing infected files. Use the troubleshooting steps as a guideline to help diagnose and repair problems.

After completing this section, you will meet these objectives:

- Review the troubleshooting process.
- Identify common problems and solutions.

Review the Troubleshooting Process

Computer technicians must be able to analyze a security threat and determine the appropriate method to protect assets and repair damage. This process is called *troubleshooting*.

Step 1: Gather Data from the Customer

The first step in the troubleshooting process is to gather data from the customer. Table 9-3 lists open-ended and closed-ended questions to ask the customer about security issues. (This list is *not* comprehensive.)

Table 9-3 Security Issues: Open-Ended and Closed-Ended Questions to Ask

Open-Ended Questions	Closed-Ended Questions
When did the problem start?	Has anyone else used your computer?
What problems are you experiencing?	Is your security software up to date?
Can you tell me anything else about the problem?	Have you scanned your computer recently for viruses?
What websites have you visited recently?	Did you open any attachments from a suspicious e-mail?
What security software is installed on your computer?	Have you ever had any problems like this before?
How are you connected to the Internet?	Have you changed your password recently?
Have any unexpected visitors been in your work area?	Have you received any error messages on your computer?
	Have you told anyone your password?

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Step 2: Verify the Obvious Issues

After you have talked to the customer, you should verify the obvious issues. Here are some issues that apply to laptops:

- Have people asked you to stop sending them strange e-mails even though you have not sent them anything?
- Have any items on your desktop been moved?
- Has your computer been running slower than normal, or is it unresponsive?
- Do you see any unfamiliar login addresses in the login window?
- Are there any unexplained entries in the security protection software logs?
- Is your Internet connection unusually slow?

Step 3: Try Quick Solutions First

After you have verified the obvious issues, try some quick solutions:

- Reboot the computer or network device.
- Log in as a different user.
- Check that the antivirus and spyware signature files are up-to-date.
- Scan the computer with protection software.
- Check the computer for the latest operating system patches and updates.
- Disconnect from the network.
- Change your password.

Step 4: Gather Data from the Computer

If quick solutions do not correct the problem, it is time to gather data from the computer:

- Verify that the signature file is current.
- Check the security software log file for entries.

Step 5: Evaluate the Problem and Implement the Solution

At this point, you have enough information to evaluate the problem and to research and implement possible solutions. Here are some resources for possible solutions:

- Problem-solving experience
- Other technicians
- Internet search

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- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

Step 6: Close with the Customer

After you have solved the problem, you close with the customer. Here are the steps required to complete this task:

How To

Step 1. Discuss the solution implemented with the customer.

Step 2. Have the customer verify that the problem has been solved.

Step 3. Provide the customer with all the paperwork.

Step 4. Document the steps taken to solve the problem in the work order and the technician's journal.

Step 5. Document any components used in the repair.

Step 6. Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Maintaining a computer can be a challenge. One of the biggest challenges is making sure that your computer software is updated and secure. Table 9-4 is a chart of common security issues and solutions.

Table 9-4 Common Security-Related Issues and Solutions

Possible Security Issue	Possible Solution
A computer runs updates and requires rebooting at inconvenient times.	Set Windows Automatic Update to run daily at a convenient time, such as lunchtime.
A wireless network is compromised even though 64-bit WEP encryption is in use.	Upgrade to 128-bit WEP security, WAP, or EAP-Cisco security.

continues

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Table 9-4 Common Security-Related Issues and Solutions *continued*

Possible Security Issue	Possible Solution
The police return a stolen laptop. The user no longer needs it.	After recovering any sensitive data, destroy the hard drive and recycle the computer.
A user complains that his system receives hundreds or thousands of junk e-mails daily.	This may be a denial-of-service attack. At the e-mail server, filter out e-mail from the sender.
A printer repair person no one remembers seeing before is observed looking under keyboards and on desktops.	Contact security or the police. Advise users never to hide passwords near their work area.



Remote Technician 9.5.2: Gather Information from the Customer

In this Remote Technician Activity, you gather data from the customer to begin the troubleshooting process and document the customer's problem in the work order provided in the activity. Refer to the Remote Technician Activity in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this activity now or wait until the end of the chapter.

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Summary

This chapter discussed computer security and why it is important to protect computer equipment, networks, and data. Threats, procedures, and preventive maintenance relating to data and physical security were described to help you keep computer equipment and data safe. Security protects computers, network equipment, and data from loss and physical danger. The following are some of the important concepts to remember from this chapter:

- Security threats can come from inside or outside an organization.
- Viruses and worms are common threats that attack data.
- Develop and maintain a security plan to protect both data and physical equipment from loss.
- Keep operating systems and applications up to date and secure with patches and service packs.

Summary of Exercises

This is a summary of the worksheets and Remote Technician exercises associated with this chapter.



Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Worksheet 9.1.0: Security Attacks

Worksheet 9.2.1: Third-Party Antivirus Software

Worksheet 9.4.2: Operating System Updates



Remote Technician Activity

The following activity covers material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Remote Technician 9.5.2: Gather Information from the Customer

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Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Which of the following is a software program that displays advertising on your computer?

   A. Adware
   B. Spyware
   C. Grayware
   D. Virus

2. Which of the following uses the network to duplicate its code to the hosts on a network, often without any user intervention?

   A. Adware
   B. Spyware
   C. Virus
   D. Worm

3. Which of the following is technically a worm and is a threat that is hidden in software that appears to do one thing, but does another?

   A. Virus
   B. Spyware
   C. Adware
   D. Trojan

4. Which of the following is a form of attack that prevents users from accessing normal services, such as e-mail or web server?

   A. Ping of death
   B. Denial of service
   C. E-mail bomb
   D. Distributed denial of service

5. Which of the following is an encryption system that protects data as if it is on a private network, even though the data is actually traveling over the Internet or other unsecured public networks?

   A. Data encryption
   B. Port protection
   C. Virtual private network
   D. File system security

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6. What characterizes a DDoS attack?

   A. Many hosts participate in a coordinated attack.
   B. It takes only a short time to set up.
   C. Home computers with Internet connections are not susceptible.
   D. It is easy to determine a packet's intent.

7. Which two of the following threats are physical threats?

   A. Laptops are stored in an unlocked cabinet.
   B. Antivirus software has outdated virus definitions.
   C. All users use the same generic username and password to connect to the network.
   D. The network server and network equipment are kept in the corner of the office for easy access.
   E. The computers are secured to the desks of each user.

8. Which type of security threat installs to a computer without the user's knowledge and then monitors all computer activity?

   A. Adware
   B. Grayware
   C. Malware
   D. Spyware

9. Which type of security threat uses e-mail that appears to be from a legitimate sender and asks the e-mail recipient to visit a website to enter confidential information?

   A. Badware
   B. Phishing
   C. Stealth virus
   D. Worm

10. A technician is attempting to secure a wireless network. Which two options should be performed to secure access to the network?

   A. Change the default administrator password for all access points.
   B. Install a security appliance to stop all wireless traffic.
   C. Enable the broadcasting of the SSID for only one access point.
   D. Use MAC filtering.
   E. Use the default SSID values for the access points.

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11. A technician has configured a wireless network with WEP encryption. Several users who were able to use the wireless network are now unable to connect to the access point. What is the probable cause of the connection problem?

A. WEP is a strong encryption technique that requires a successful handshake to establish connectivity.

B. The access point cannot broadcast SSIDs when WEP is enabled.

C. The users have not configured their computers for WEP encryption.

D. The access point uses 64-bit encryption, which is obsolete with newer wireless NICs.

12. Which step should a technician perform first when troubleshooting security issues?

A. Gather data from the computer.

B. Gather data from the customer.

C. Evaluate the problem.

D. Verify the obvious issues.

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CHAPTER 10

Communication Skills

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- What is the relationship between communication and troubleshooting?
- Why are good communication skills and professional behavior important?
- Does working with computer technology have ethical and legal aspects?
- What is a call center environment, and what are the technician's responsibilities?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

troubleshooting *page xx*

communication skills *page xx*

professionalism *page xx*

talkative customer *page xx*

rude customer *page xx*

angry customer *page xx*

knowledgeable customer *page xx*

level-one technician *page xx*

level-two technician *page xx*

inexperienced customer *page xx*

Netiquette *page xx*

workstation ergonomics *page xx*

time management *page xx*

stress management *page xx*

service level agreement (SLA) *page xx*

business policy *page xx*

customer call rule *page xx*

call center employee rule *page xx*

ethical custom *page xx*

legal rule *page xx*

call center environment *page xx*

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What is the relationship between communication skills and troubleshooting? As a computer technician, you will not only fix computers; you also will interact with people. In fact, ***troubleshooting*** is as much about communicating with the customer as it is about knowing how to fix a computer. In this chapter, you will learn how to use good communication skills as confidently as you use a screwdriver.

Explain the Relationship Between Communication and Troubleshooting

Think of a time when you had to call a repair person to get something fixed. Did it feel like an emergency to you? Did you appreciate it when the repair person was sympathetic and responsive? Perhaps you had a bad experience with a repair person. Are you likely to call that same person to fix a problem again?

Good ***communication skills*** enhance a technician's troubleshooting skills. Both of these skill sets take time and experience to develop. As your hardware, software, and operating system knowledge increases, your ability to quickly determine a problem and find a solution will improve. The same principle applies to developing communication skills. The more you practice good communication skills, the more effective you will become when working with customers. A knowledgeable technician who uses good communication skills will always be in demand in the job market.

To troubleshoot a computer, you need to learn the details of the problem from the customer. Most people who need a computer problem fixed are probably feeling some stress. If you establish a good rapport with the customer, he or she may relax a bit. A relaxed customer is more likely to provide the information you need to determine the source of the problem and then fix it.

Speaking directly with the customer is usually the first step in resolving the computer problem. As a technician, you will have access to several communication and research tools. You can use all these resources to gather information for the troubleshooting process. Some examples of technician resources are

- Personal experience
- Scripts
- Websites
- Search engines
- Online FAQs
- Coworkers
- Support vendors

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- Diagnostic repair tools
- Manufacturer manuals
- E-mail



Worksheet 10.1.0: Technician Resources

In this worksheet, you use the Internet to find online resources for a specific computer component and then search online for resources that can help you troubleshoot the component. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

Describe Good Communication Skills and Professional Behavior

Whether you are talking with a customer on the phone or in person, it is important to communicate well and to represent yourself professionally. Your ***professionalism*** and good communication skills will enhance your creditability with the customer.

A customer can "see" your body language. A customer can hear your sighs and sense that you are sneering, even over the phone. Conversely, customers can also sense that you are smiling when you speak with them on the phone. Many call-center technicians have a mirror at their desk to monitor their facial expressions.

Successful technicians control their reactions and emotions from one customer call to the next. A good rule for all technicians to follow is that a new customer call means a fresh start. Never carry your frustration from one call to the next.

After completing this section, you will meet these objectives:

- Determine the customer's computer problem.
- Display professional behavior with the customer.
- Focus the customer on the problem during the call.
- Use proper Netiquette.
- Implement workstation ergonomics and time- and stress-management techniques.
- Observe service level agreements (SLA).
- Follow business policies.

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Determine the Customer's Computer Problem

One of the technician's first tasks is to determine the type of computer problem that the customer is experiencing.

Remember these three rules at the beginning of your conversation:

- **Know:** Call your customer by name.
- **Relate:** Use brief communication to create a one-to-one connection between you and your customer.
- **Understand:** Determine the customer's level of knowledge about her computer to know how to effectively communicate with her.

To accomplish these tasks, you should practice active listening skills. Allow the customer to tell the whole story. As the customer is explaining the problem, occasionally interject a small word or phrase, such as "I understand," "Yes," "I see," or "Okay." This behavior lets the customer know that you are there and listening. This is not the same as interrupting the customer to ask a question or make a statement.

A technician should not interrupt the customer to ask a question or make a statement. This is rude and disrespectful and creates tension. Many times in a conversation, you might find yourself thinking about what to say before the other person finishes talking. When you do this, you are not really listening. As practice, try listening carefully when other people speak, and let them finish their thoughts.

After you have listened to the customer explain the whole problem, clarify what the person has said. This helps convince the customer that you have heard and understand the situation. A good practice for clarification is to paraphrase the customer's explanation by beginning with "Let me see if I understand what you have told me...." This is a very effective tool that shows the customer that you have listened and that you are concerned about the issues.

After you have assured the customer that you understand the problem, you will probably have to ask some follow-up questions. Make sure that these questions are pertinent. Do not ask questions that the customer has already answered while describing the problem. Doing this only irritates the customer and shows that you were not listening.

Follow-up questions should be targeted, closed-ended questions based on the information you have already gathered. Closed-ended questions should focus on obtaining specific information. The customer should be able to answer with a simple "yes" or "no" or with a factual response such as "Windows XP Pro." Use all the information you have gathered from the customer to continue filling out the work order.

Display Professional Behavior with the Customer

When dealing with customers, you must be professional in all aspects of your role. You must handle customers with respect and prompt attention. When on the phone, make sure

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that you know how to put a customer on hold, as well as how to transfer a customer without losing the call. How you conduct the call is important. Your job is to help the customer focus on and communicate the problem so that you can solve it.

Be positive when communicating with the customer. Tell him what you can do. Do not focus on what you cannot do. Be prepared to explain alternative ways in which you can help him, such as e-mailing information, faxing step-by-step instructions, or using remote-control software to solve the problem. Customers will quickly sense whether you are interested in helping them.

Here are some recommendations to follow before you put a customer on hold. First, let the customer finish speaking. Then, explain that you have to put him on hold, and ask him for permission to do so. When the customer agrees to be put on hold, thank him. Tell him that you will be away only a few minutes, and explain what you will be doing during that time.

Table 10-1 lists dos and don'ts for conversing with a customer.

Table 10-1 Customer Communication Dos and Don'ts

Do	Don't
Let the customer finish talking.	Interrupt.
Tell the customer that you must put him on hold, and explain why.	Abruptly put the customer on hold.
Ask if it is all right to put the customer on hold.	Put the customer on hold without an explanation and the customer's consent.
After you are given consent, tell the customer you will be just a minute.	

Follow the same process for a call transfer as you do when placing a customer on hold. Let the customer finish talking, and then explain that you have to transfer the call. When the customer agrees to be transferred, tell her the phone number that you are transferring her to. You should also tell the new technician your name, the name of the customer you are transferring, and the related ticket number.

Table 10-2 lists dos and don'ts for transferring a call from the customer.

Table 10-2 Customer Call Transfer Dos and Don'ts

Do	Don't
Let the customer finish talking.	Interrupt.
Explain that you have to transfer the call, and tell the customer to whom and why.	Abruptly transfer the call.

continues

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Table 10-2 Customer Call Transfer Dos and Don'ts *continued*

Do	Don't
Tell the customer the number you are transferring her to (for example, 142).	Transfer without an explanation and the customer's consent.
Ask if it is all right to transfer the call now.	Transfer without informing the new tech.
After you are given consent, begin the transfer.	
Tell the new tech who you are, the ticket number, and the customer's name.	

When dealing with customers, it is sometimes easier to explain what you should *not* do. Observe the following list of things you should *avoid* when communicating with a customer:

- Minimizing customer problems.
- Using jargon, abbreviations, and acronyms.
- Displaying a negative attitude or using a negative tone of voice.
- Arguing with customers or becoming defensive.
- Being judgmental or insulting or calling the customer names.
- Distractions and interruptions when talking with customers.
- Unnecessary and abrupt holds.
- Transferring a call without explaining the purpose of the transfer and getting the customer's consent.
- Making negative remarks about other technicians to the customer.

Class Discussion 10.2.2: Controlling the Call

In this activity, the class discusses positive ways to tell customers negative things through the use of four scenarios. Refer to the relevant topics in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition to help you prepare for this discussion.

Focus the Customer on the Problem During the Call

Part of your job is to focus the customer during the phone call. Keeping the customer focused on the problem allows you to control the call. This makes the best use of your time

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and the customer's time on troubleshooting the problem. Do not take any comments personally, and do not retaliate with comments or criticism. If you stay calm, finding a solution to the problem remains the focal point of the call.

Just as there are many different computer problems, there are many different types of customers. The list of problem-customer types described in the following sections is not comprehensive; often a customer can display a combination of traits. You need to recognize which traits your customer exhibits. Recognizing these traits will help you manage the call accordingly.

Talkative Customer

A ***talkative customer*** discusses everything except the problem. This kind of customer often uses the call as an opportunity to socialize. It can be difficult to get a talkative customer to focus on the problem. Table 10-3 lists dos and don'ts for dealing with a talkative customer.

Table 10-3 Dealing with a Talkative Customer Dos and Don'ts

Do	Don't
Allow the customer to talk for one minute.	Encourage non-problem-related conversation by asking social questions such as "How are you today?"
Gather as much information about the problem as possible.	
Politely step in to refocus the customer. This is the exception to the rule of never interrupting a customer.	
Ask as many closed-ended questions as you need to after you have regained control of the call.	

Rude Customer

A ***rude customer*** complains during the call and often makes negative comments about the product, the service, and the technician. This type of customer is sometimes abusive and uncooperative and is easily aggravated. Table 10-4 lists dos and don'ts for dealing with a rude customer.

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Table 10-4 Dealing with a Rude Customer Dos and Don'ts

Do	Don't
Listen carefully, because you do not want to ask the customer to repeat any information.	Ask the customer to follow any obvious steps if there is any way you can determine the problem without the customer.
Follow a step-by-step approach to determining and solving the problem.	Be rude to the customer.
If the customer has a favorite technician, try to contact that technician to see if he or she can take the call. For example, tell the customer, "I can either help you right now or see if (the preferred technician) is available. He will be available in two hours. Is that acceptable?" If the customer wants to wait for the other technician, record this in the ticket.	
Apologize for the wait time and the inconvenience, even if there has been no wait time.	
Reiterate that you want to solve the customer's problem as quickly as possible.	

Angry Customer

An ***angry customer*** talks loudly during the call and often tries to speak when the technician is talking. Angry customers are usually frustrated that they have a problem and upset that they have to call somebody to fix it. Table 10-5 lists dos and don'ts for dealing with an angry customer.

Table 10-5 Dealing with an Angry Customer Dos and Don'ts

Do	Don't
Let the customer explain his problem without interrupting, even if he is angry. This allows the customer to release some of his anger before you proceed.	If at all possible, try not to put this customer on hold or transfer the call.
Sympathize with the customer's problem.	Spend call time talking about what caused the problem. Instead, redirect the conversation to solving the problem.
Apologize for the wait time or inconvenience.	

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Knowledgeable Customer

A ***knowledgeable customer*** wants to speak with a technician who is equally experienced in computers. This type of customer usually tries to control the call and does not want to speak with a ***level-one technician***. Table 10-6 lists dos and don'ts for dealing with a knowledgeable customer.

Table 10-6 Dealing with a Knowledgeable Customer Dos and Don'ts

Do	Don't
If you are a level-one technician, you might try to set up a conference call with a ***level-two technician***.	Follow a step-by-step process with the customer.
Explain your overall approach to what you are trying to verify.	Ask the customer to check the obvious, such as the power cord or the power switch. For example, you could suggest a reboot instead.

Inexperienced Customer

An ***inexperienced customer*** has difficulty describing the problem. These customers usually can't follow directions or communicate the errors they encounter. Table 10-7 lists dos and don'ts for dealing with an inexperienced customer.

Table 10-7 Dealing with an Inexperienced Customer Dos and Don'ts

Do	Don't
Use a simple step-by-step process of instructions.	Use industry jargon.
Speak in plain terms.	Condescend to your customer or belittle him or her.

Class Discussion 10.2.3: Identifying Difficult Customer Types

In this activity, the class identifies difficult customer types through the use of five scenarios. Refer to the relevant topics in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition to help you prepare for this discussion.

Use Proper Netiquette

Have you read a blog where two or three members have stopped discussing the issue and are simply insulting each other? These are called "flame wars," and they occur in blogs and

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e-mail threads. Have you ever wondered if they would say those things to each other in person? Perhaps you have received an e-mail that had no greeting or was written entirely in capital letters. How did this make you feel?

As a technician, you should be professional in all communications with customers. E-mail and text communications have a set of personal and business etiquette rules called ***Netiquette***.

In addition to e-mail and text Netiquette, general rules apply to all your online interactions with customers and coworkers:

- Remember that you are dealing with people.
- Adhere to the same standards of behavior that you follow in real life.
- Respect people's time and bandwidth.
- Share expert knowledge.
- Do not engage in "flame wars" online.
- Respect people's privacy.
- Be forgiving of people's mistakes.

The preceding list is not comprehensive. When dealing with a customer, consider all the rules about online communication that you can think of.

Implement Workstation Ergonomics and Time- and Stress-Management Techniques

As a technician, you are a very busy person. It is important for your well-being to ensure that your work area is as comfortable as possible and that you use proper time- and stress-management techniques. The following sections describe these considerations and techniques in greater detail.

Workstation Ergonomics

The ergonomics of your work area (its design and arrangement for optimum safe and efficient interaction) can help you do your job or make it more difficult. Because you may spend the major portion of your day at your workstation, make sure that the desk layout works well, as shown in Figure 10-1. Have your headset and phone in a position that is both easy to reach and easy to use. Your chair should be adjusted to a height that is comfortable. Adjust your computer screen to a comfortable angle so that you do not have to tilt your head to see it. Make sure your keyboard and mouse are also in a comfortable position. You should not have to bend your wrists to type. If possible, try to minimize external distractions such as noise.

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Figure 10-1 ***Workstation Ergonomics***



Time Management

For ***time management***, it is important to prioritize your activities. Make sure that you carefully follow your company's business policy. The company policy may state that you must take "down" calls first, even though they may be harder to solve. A "down" call usually means that a server is not working and the entire office or company is waiting for the problem to be resolved before they can resume business.

If you have to call a customer back, make sure that you do so as close to the callback time as possible. Keep a list of callback customers, and check them off one at a time as you complete these calls. Doing this ensures that you do not forget a customer.

When working with many customers, do not give your favorite customers faster or better service. When reviewing the call boards (as shown in Figure 10-2), do not take only the easy calls. Do not take the call of another technician unless you have permission to do so.

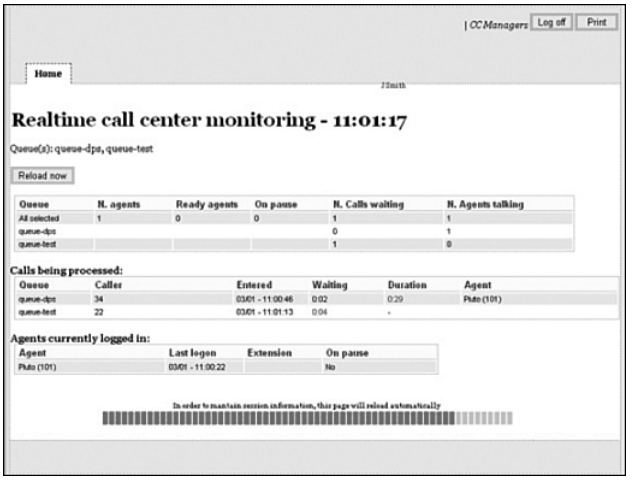
Stress Management

For ***stress management***, take a moment to compose yourself between customer calls. Every call should be independent of the others. Do not carry any frustrations from one call to the next.

You might have to do some physical activity to relieve stress. Stand up and take a short walk. Do a few simple stretch movements or squeeze a tension ball. Take a break if you can, and try to relax. You then will be ready to answer the next customer call effectively.

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Figure 10-2 Call Board



Here are some ways to relax:

- Practice relaxed breathing: inhale-hold-exhale-repeat.
- Listen to soothing sounds.
- Massage your temples.
- Take a break. Go for a quick walk, or climb a flight of stairs.
- Eat something small (a snack with protein is best).
- Plan your weekend.
- Avoid stimulants such as coffee, carbonated drinks, and chocolate. All contain caffeine and can add to stress.

Think of other appropriate activities that might relieve stress for you at work.

Observe Service Level Agreements (SLA)

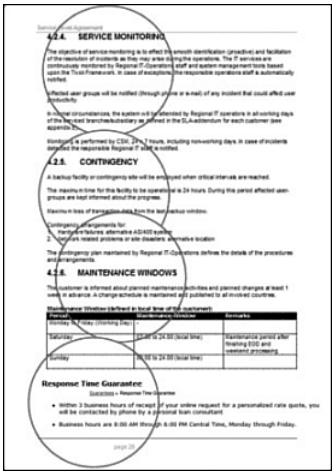
When dealing with customers, it is important to adhere to that customer's ***service level agreement (SLA)***. This is a contract that defines expectations between an organization and the service vendor to provide an agreed-upon level of support. As an employee of the service company, your job is to honor the SLA that you have with the customer. Figure 10-3 shows a sample SLA with some of the standard sections highlighted:

- Service monitoring
- Contingency

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- Maintenance windows
- Response time guarantee

Figure 10-3 Service Level Agreement



An SLA typically is a legal agreement that describes the responsibilities and liabilities of all parties involved. Some of the contents of an SLA usually include the following:

- Response-time guarantees (often based on the type of call and the SLA)
- Equipment and/or software that will be supported
- Where service will be provided
- Preventive maintenance
- Diagnostics
- Part availability (equivalent parts)
- Cost and penalties
- Time of service availability (for example, 24/7; Monday through Friday; 8 a.m. to 5 p.m. EST; and so on)

There may be exceptions to the SLA. Be sure to follow your company business rules in detail. Some of the exceptions may include the customer's ability to upgrade the service level and the ability to escalate to management for review. Escalation to management should be reserved for special situations. For example, a long-standing customer or a customer from a very large company might have a problem that falls outside the parameters stated in his or her SLA with your service company. In these cases, your management may choose to support the customer for customer-relations reasons.

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Consider other circumstances in which it might be a good idea to escalate a call to management.

Follow Business Policies

As a technician, you should be aware of all ***business policies*** related to customer calls. Don't make a promise to a customer that you cannot keep. You should also have a good understanding of all rules governing employees. Table 10-8 lists typical ***customer call rules*** as well as ***call center employee rules***.

Table 10-8 Customer Call and Call Center Employee Rules

Customer Call Rules	Call Center Employee Rules
Maximum time on call (example: 15 minutes)	Arrive at your workstation early enough to be prepared, usually about 15 to 20 minutes before the first call.
Maximum call time in queue (example: three minutes)	Do not exceed the allowed number and length of breaks.
Number of calls per day (example: minimum of 30)	Do not take a break or go to lunch if a call is on the board.
Rules about passing calls to other technicians (example: only when absolutely necessary, and not without that technician's permission)	Do not take a break or go to lunch at the same time as other technicians. Stagger breaks among technicians.
Rules about what you can and cannot promise to the customer (see that customer's SLA for details)	Do not leave an ongoing call to take a break or go to lunch.
When to follow the SLA and when to escalate to management	Make sure that another technician is available if you have to leave.
	If no other technician is available, check with the customer to see if you can call back later, possibly in the morning.
	Do not show favoritism to certain customers.
	Do not take another technician's calls without permission.
	Do not talk negatively about the capabilities of another technician.

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Explain Ethics and Legal Aspects of Working with Computer Technology

When you are working with customers and their equipment, you should observe some general ethical customs and legal rules. Often, these customs and rules overlap.

Ethical Customs

You should always respect your customers, as well as their property. Property includes any information or data that may be accessible. Information or data that is subject to ***ethical customs*** includes the following items:

- E-mails
- Phone lists
- Records or data on the computer
- Hard copies of files, information, or data left on the desk

Before accessing a computer account, including the administrator account, you should get the customer's permission. From the troubleshooting process, you may have gathered some private information, such as usernames and passwords. If you document this type of private information, you must keep it confidential. Divulging any customer information to anyone else is not only unethical, but it might be illegal. Legal details of customer information are usually covered under the SLA.

Do not send unsolicited messages to a customer. Do not send unsolicited mass mailings or chain letters to customers. Never send forged or anonymous e-mails. All these activities are considered unethical and, in certain circumstances, may be illegal. In either case, these activities could result in job termination.

Legal Rules

Several computer-related activities are not only unethical, but illegal. Be aware that this is not an exhaustive list of ***legal rules***:

- Do not make any changes to system software or hardware configurations without the customer's permission.
- Do not access a customer's or coworker's accounts, private files, or e-mail messages without permission.
- Do not install, copy, or share digital content (including software, music, text, images, and video) in violation of copyright or software agreements or applicable federal and state laws.
- Do not use a customer's company IT resources for commercial purposes.

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- Do not make a customer's IT resources available to unauthorized users.
- Keep sensitive customer information confidential.
- Do not knowingly use a customer's company resources for illegal activities. Criminal or illegal use may include child pornography, threats, harassment, copyright infringement, university trademark infringement, defamation, theft, identity theft, and unauthorized access.

Make sure you know the copyright and trademark laws in your state or country.

Class Discussion 10.3.0: Customer Privacy

In this activity, the class discusses the importance of respecting customer privacy through the use of three scenarios. Refer to the relevant topics in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition to help you prepare for this discussion.

Describe the Call Center Environment and Technician Responsibilities

A ***call center environment*** is usually very professional and fast-paced. A call center is a help desk system where customers call in and are placed on a call board. Available technicians take the customer calls. A technician must supply the level of support that is outlined in the customer's SLA.

After completing this section, you will meet these objectives:

- Describe the call center environment.
- Describe level-one technician responsibilities.
- Describe level-two technician responsibilities.

Describe the Call Center Environment

A call center may exist within a company and offer service to the employees of that company as well as to the customers of that company's products. Alternatively, a call center may be an independent business that sells computer support as a service to outside customers. In either case, a call center is a busy, fast-paced work environment, often operating 24 hours a day.

Call centers tend to have a large number of cubicles. Each cubicle has a chair, at least one computer, and a phone with a headset. The technicians working at these cubicles have varied levels of experience in computers. Some have specialties in certain types of computers, software, or operating systems.

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All the computers in a call center have help-desk software. The technicians use this software to manage many of their job functions. Although it is not a complete list of most features of help-desk software, the following list provides more detail:

- **Log and track incidents:** The software may manage call queues, set call priorities, assign calls, and escalate calls.
- **Record contact information:** The software may store, edit, and recall customer names, e-mail addresses, phone numbers, locations, websites, fax numbers, and other information in a database.
- **Research product information:** The software may provide to technicians information on the products they support, including features, limitations, new versions, configuration constraints, known bugs, product availability, links to online help files, and other information.
- **Run diagnostic utilities:** The software may have several diagnostic utilities, including remote diagnostic software, in which the technician can "take over" a customer's computer while sitting at a desk in the call center.
- **Research a knowledge base:** The software may contain a knowledge database that is preprogrammed with common problems and their solutions. This database may grow as technicians add their own records of problems and solutions.
- **Collect customer feedback:** The software may collect customer feedback on satisfaction with the call center's products and services.

Your call center will have its own business policies for call priority. Table 10-9 is a sample chart of how calls may be named, defined, and prioritized.

Table 10-9 Call Prioritization

Name	Definition	Priority
Down	The company cannot operate any computer equipment.	1 (most urgent)
Hardware	One or more computers are not functioning correctly.	2 (urgent)
Software system errors.	One or more computers have software or operating	2 (urgent)
Network	One or more computers cannot access the network.	2 (urgent)
Enhancement	Request for additional functionality.	3 (important)

Describe Level-One Technician Responsibilities

Call centers sometimes have different names for level-one technicians. These technicians may be known as level-one analysts, dispatchers, or incident screeners. Regardless of the

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title, the level-one technician's responsibilities are fairly similar from one call center to the next.

The primary responsibility of a level-one technician is to gather pertinent information from the customer. The technician has to document all the information in the ticket or work order. Here is some of the information a level-one technician must obtain:

- Contact information
- Description of the problem
- Priority of the problem
- The computer's manufacturer and model
- The computer's operating system
- Whether the computer uses AC or DC power
- Whether the computer is on a network and, if so, whether it is a wired or wireless connection
- If a specific application was being used when the problem occurred
- If any new drivers or updates have been installed recently and, if so, what they are

Some problems are very simple to resolve, and a level-one technician usually can take care of these without escalating the work order to a level-two technician.

Often, a problem requires the expertise of a level-two technician. In these cases, the level-one technician must be able to translate the customer's problem description into a succinct sentence or two that are entered into the work order. This translation is important so that other technicians can quickly understand the situation without having to ask the customer the same questions again. Table 10-10 shows how a customer might describe some of the most common problems and how a technician should document those problems.

Table 10-10 Customer and Technician Problems

Customer Problem Description	Technician Documentation
Printer does not print.	The printer prints a test page but does not print from a specified application.
Mouse does not work.	The mouse is dirty, and the user is unable to control the cursor.
Cannot get onto the network.	The user is unable to log in to the network.
Monitor does not work.	The monitor settings have been altered. No images can be seen on the screen.
Computer does not turn on.	The computer does not boot to the Windows desktop.

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Describe Level-Two Technician Responsibilities

As with level-one technicians, call centers sometimes have different names for level-two technicians. These technicians may be known as product specialists or technical-support personnel. The level-two technician's responsibilities generally are the same from one call center to the next.

The level-two technician is usually more knowledgeable than the level-one technician about technology, or has been working for the company for a longer period of time. When a problem cannot be resolved within ten minutes, the level-one technician prepares an escalated work order. The level-two technician receives the escalated work order with the description of the problem. That person then calls the customer back to ask additional questions and resolve the problem.

The following list of guidelines details when to escalate a problem to a more experienced technician. These are generic guidelines; you should follow your company's business policy for problem escalation.

- Escalate problems that require opening the computer case.
- Escalate problems that require installing applications, operating systems, or drivers.
- Escalate problems that will take a long time to walk a customer through, such as Configuration Memory Operating System (CMOS) changes.
- Escalate "down" calls. The entire network is down, and a more experienced tech may be able to resolve the issue faster.

Problems that require opening the computer case need a level-two technician. Level-two technicians can also use remote diagnostic software to connect to the customer's computer to update drivers and software, access the operating system, check the BIOS, and gather other diagnostic information to solve the problem.

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Summary

In this chapter, you learned about the relationship between communication skills and troubleshooting skills. You have learned that these two skills need to be combined to make you a successful technician. You also learned about the legal aspects and ethics of dealing with computer technology and the customer's property.

The following concepts from this chapter are important to remember:

- To be a successful technician, you need to practice good communication skills with customers and coworkers. These skills are as important as technical expertise.
- You should always conduct yourself in a professional manner with your customers and coworkers. Professional behavior increases customer confidence and enhances your credibility. You should also learn to recognize the classic signs of a difficult customer and learn what to do and what not to do when you are on a call with this customer.
- You can use a few techniques to keep a difficult customer focused on the problem during a call. Primarily, you must remain calm and ask pertinent questions in an appropriate fashion. These techniques keep you in control of the call.
- There is a right way and a wrong way to put a customer on hold, or transfer a customer to another technician. Learn and use the right way every time. Performing either of these operations incorrectly can seriously damage your company's relationship with its customers.
- Netiquette is a list of rules to use whenever you communicate through e-mail, text messaging, instant messaging, or blogs. This is another area where doing things the wrong way can damage your company's relationship with its customers.
- You must understand and comply with your customer's service level agreement (SLA). If the problem falls outside the SLA, you need to find positive ways of telling the customer what you can do to help, not what you cannot do. In special circumstances, you may decide to escalate the work order to management.
- In addition to the SLA, you must follow the company's business policies. These policies include how your company prioritizes calls, how and when to escalate a call to management, and when you are allowed to take breaks and lunch.
- A computer technician's job is stressful. You will rarely talk to a customer who is having a good day. You can alleviate some of the stress by setting up your workstation in the most ergonomic way possible. You should practice time- and stress-management techniques every day.
- There are ethical and legal aspects to working in computer technology. You should be aware of your company's policies and practices. In addition, you may need to become familiar with your state or country's trademark and copyright laws.

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- The call center is a fast-paced environment. Level-one technicians and level-two technicians each have specific responsibilities. These responsibilities may vary slightly from one call center to another.

Summary of Exercises

This is a summary of the Labs, Worksheets, Remote Technician exercises, Class Discussions, Virtual Desktop activities, and Virtual Laptop activities associated with this chapter.



Worksheets

The following Worksheet covers material from this chapter. Refer to the Worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition.

Worksheet 10.1.0: Technician Resources



Class Discussions

The following Class Discussions cover material from this chapter. Refer to these topics in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition.

Class Discussion 10.2.2: Controlling the Call

Class Discussion 10.2.3: Identifying Difficult Customer Types

Class Discussion 10.3.0: Customer Privacy

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. What is a good rule for a call center technician to follow?

   A. Be proactive by avoiding speaking with upset or angry customers.

   B. Consider each new customer call a fresh start.

   C. Go with your first impression of the customer, and use Netiquette.

   D. Focus on how to repair the problem while the customer is speaking.

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2. Which two actions are examples of good Netiquette?

A. Avoid beginning an e-mail with a formal greeting when it is a reply.

B. Check grammar and spelling before sending an e-mail.

C. Use both uppercase and lowercase letters in e-mails instead of all uppercase or all lowercase.

D. Reply to flames, but not via e-mail.

3. What is an SLA?

A. An itemized record detailing all levels of service performed on equipment covered by a manufacturer warranty

B. A legal agreement between a customer and a service technician confirming specific services performed on equipment not covered by any warranty

C. A legal agreement between a customer and the service vendor confirming a specific level of support

D. A legal record of customer invoices showing that all expenses were approved before the repair of equipment

4. What is the primary responsibility of a level-one technician?

A. Determining the cause of complex computer problems

B. Gathering information from the customer

C. Using remote diagnostic software to connect to the customer's computer

D. Resolving computer problems that require opening the computer case

5. Which task is the responsibility of a level-two technician?

A. Resolving computer problems that are limited to software errors

B. Gathering information from the customer

C. Directing the customer to the appropriate computer vendor for help

D. Resolving computer problems that require opening the computer case

6. Which two skills are the most important for a successful computer technician to possess?

A. Communication

B. Computer repair

C. Task maintenance

D. Work escalation

E. Computer prioritization

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7. What is the proper way to conduct a telephone call to troubleshoot a computer problem?

   A. Always gather information from the customer and escalate the problem.
   B. Maintain professional behavior at all times.
   C. Ask personal questions to get better acquainted with the customer.
   D. Explain each step to help the customer understand the troubleshooting process.

8. A user calls to report that his new computer is broken. The technician determines that the user is inexperienced and possesses a limited understanding of computer technology. How should the technician handle this call?

   A. Write up a brief trouble ticket and send a technician to the customer to resolve the computer problem.
   B. Attempt to gather information using a simple step-by-step process to determine the problem.
   C. Explain technical terms to the customer to educate him so that he can describe the problem.
   D. Direct the user to several websites to help him identify the problem.

9. A customer calls, asking for help with an error code displayed on a computer running Linux. The technician has limited experience with Linux. What should she do?

   A. Attempt the repair anyway.
   B. Apologize, and tell the customer that she hopes to receive training for Linux in the future.
   C. Gather information about the problem and escalate the call to a level-two technician.
   D. Direct the customer to the manufacturer's website.

10. Your office informs you that a customer will be contacting you by cell phone within the next ten minutes about an emergency. The customer does not contact you before your next appointment with another customer. What should you do if the previous customer calls you while you are with the next customer?

    A. Call your supervisor.
    B. Let the call go to voice mail.
    C. Excuse yourself and take the call.
    D. Send the customer a text message.

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11. A customer who just contacted you is very angry about your company's service. During the call, you discover that another technician responded to the customer's issue. What should you do?

A. Stay calm.

B. Ask for clarification.

C. Ask the customer what would make the situation better.

D. Transfer the customer to the technician who initially handled the issue.

12. A customer calls you and explains in great detail a problem she is having with her computer. What should you do?

A. Interrupt her and obtain only the relevant information.

B. Interrupt her and obtain only the basic information.

C. Allow her to finish explaining the problem, and record all the details she gives you.

D. Allow her to finish explaining the problem, but record only the information you feel is relevant.

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CHAPTER 11

Advanced Personal Computers

Objectives

Upon completion of this chapter, you will able to answer the following questions:

- What are the differences between field, ***remote, and ben***ch ***technician job***s?
- What are safe la***b procedures an***d tool use?
- What situations require rep***lacement of com***puter components?
- How do I upgrade and configure personal computer components and peripherals?
- What are common preventive maintenance techniques for personal computer components and how do I identify and apply them?
- How can I troubleshoot computer components and peripherals?

******end bulleted list***

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

electrostatic discharge (ESD) *page xx*

antistatic wrist strap *page xx*

antistatic mat *page xx*

power supply *page xx*

motherboard *page xx*

random-access memory (RAM) *page xx*

adapter cards *page xx*

central processing unit (CPU) *page xx*

heat sink/fan *page xx*

basic input/output system (BIOS) *page xx*

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In your career as a technician, you might have to determine whether a component for a customer's computer should be upgraded or replaced. It is important that you develop advanced skills in installation procedures, troubleshooting techniques, and diagnostic methods for computers. This chapter discusses the importance of component compatibility across hardware and software. It also covers the need for adequate system resources to efficiently run the customer's hardware and software.

Give an Overview of Field, Remote, and Bench Technician Jobs

Your experience working with computers and earning a technical certification can help you become qualified for employment as any of the following:

- Field technician
- Remote technician
- Bench technician

Technicians in different computer careers work in different environments. The skills required by each career can be very similar. The degree to which different skills are needed vary from one job to the next. When you train to become a computer technician, you are expected to develop the following skills:

- Building and upgrading computers
- Performing installations
- Installing, configuring, and optimizing software
- Performing preventive maintenance
- Troubleshooting and repairing computers
- Communicating clearly with the customer
- Documenting customer feedback and the steps involved in finding the solution to a problem

Field technicians work in various conditions and businesses. You might work for one company and only repair that company's assets. Alternatively, you might work for a company that provides on-site computer equipment repair for a variety of companies and customers. In either of these situations, you need both excellent troubleshooting skills and customer service skills, because you are in regular contact with customers and work on a wide variety of hardware and software.

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If you are a remote technician, you might work at a help desk answering calls or e-mails from customers who have computer problems. You create work orders and communicate with the customer to try to diagnose and repair the problem.

Good communication skills are valuable because the customer must clearly understand your questions and instructions. Some help desks use software to connect directly to a customer's computer to fix the problem. As a remote technician, you can work on a team of help desk technicians for an organization or from home.

As a bench technician, you typically would not work directly with customers. Bench technicians are often hired to perform computer warranty service in a central depot or work facility.



Worksheet 11.1.0: Job Opportunities

In this worksheet, you research computer-related jobs. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this worksheet now or wait until the end of the chapter.

Explain Safe Lab Procedures and Tool Use

Safety should always be your priority on a job or in the lab. As a computer technician, you should be aware of the many workplace hazards, and you should take the necessary precautions to avoid them.

You should try to practice safety in the lab so that it becomes part of your regular routine. Follow all safety procedures and use the correct tools for the job. This policy will help prevent personal injury and damage to equipment.

To accomplish a safe working environment, it is better to be proactive rather than reactive. Here is a list of safety rules to help you maintain a safe working environment:

- Keep the work area clean and free of clutter.
- Keep food and drinks out of the work area.
- Never open a computer monitor unless you have been properly trained.
- Remove all your jewelry and watches.
- Make sure that the power is off and that the power plug has been removed.
- Do not look into the laser beams located in the computer equipment.
- Make sure that there is a fire extinguisher and first aid kit available.
- Cover sharp edges with tape when working inside the computer case.

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After completing this section, you will meet these objectives:

- Review safe working environment and procedures
- Review names, purposes, characteristics, and safe and appropriate use of tools
- Identify potential safety hazards and implement proper safety procedures for computer components
- Describe environmental issues

Review Safe Working Environments and Procedures

Workplace safety is necessary to ensure that you, and everyone near you, stay unharmed. In any situation, you should always follow these basic rules:

- Use antistatic mats and pads to reduce the chance of ***electrostatic discharge (ESD)*** damaging your equipment.
- Store hazardous or toxic materials in a secured cabinet.
- Keep the floor clear of anything that might trip someone.
- Clean work areas on a regular basis.

Figure 11-1 shows examples of safety equipment.

Figure 11-1 Safety Equipment



You should use caution when you move computer equipment from one place to another. Make sure that customers follow the safety rules in your work area. You might need to explain these rules and assure customers that the rules are there to protect them.

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Follow local codes and government rules whenever you dispose of such things as batteries, solvents, computers, and monitors. Failing to do so can result in a fine. Many countries have agencies to enforce safety standards and ensure safe working conditions for employees.

Review Names, Purposes, Characteristics, and Safe and Appropriate Use of Tools

A computer technician needs proper tools to work safely and to prevent damage to the computer equipment. There are many tools, as shown in Figure 11-2, that a technician uses to diagnose and repair computer problems:

- Flat head screwdriver, large and small
- Phillips head screwdriver, large and small
- Tweezers or part retriever
- Needle-nose pliers
- Wire cutters
- Chip extractor
- Hex wrench set
- Torx screwdriver
- Nut driver, large and small
- Three-claw component holder
- Digital multimeter
- Wrap plugs
- Small mirror
- Small dust brush
- Soft, lint-free cloth
- Cable ties
- Scissors
- Small flashlight
- Electrical tape
- Pencil or pen
- Compressed air

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Figure 11-2 Organized Tool Storage



Static electricity is one of the biggest concerns for computer technicians when working in many environments. The tools you use and even your own body can store or conduct thousands of volts of electricity. Walking across carpet or a rug and touching a computer component before grounding yourself can severely damage the component.

Antistatic devices help control static electricity. Use antistatic devices to prevent damage to sensitive components. Before you touch a computer component, be sure to ground yourself by touching a grounded computer chassis or mat. These are some antistatic devices:

- ***Antistatic wrist strap***: Conducts static electricity from your body to ground
- ***Antistatic mat***: Grounds the computer frame
- **Antistatic bag**: Keeps sensitive computer components safe when not installed inside a computer
- **Cleaning products**: Maintain components without creating a buildup of static electricity

Caution

To help prevent electric shock, do not wear an antistatic wrist strap when working with high-voltage circuits, such as those found in monitors and printers. Do not open monitors or power supplies unless you are properly trained.

Identify Potential Safety Hazards and Implement Proper Safety Procedures for Computer Components

Most internal computer components use low-voltage electricity. Some components, however, operate with high voltage and can be dangerous if you do not follow safety precautions.

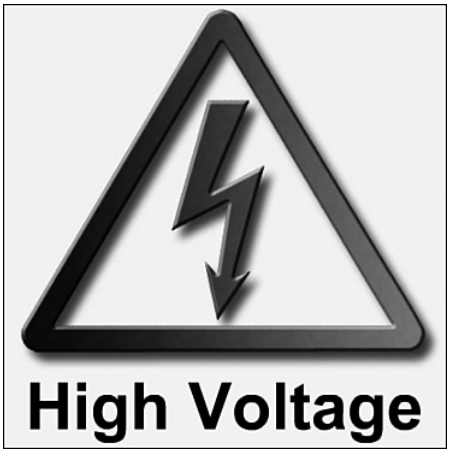
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The following dangerous, high-voltage computer components should only be serviced by authorized personnel:

- ***Power supplies***: The cost to repair a power supply can sometimes equal the cost of a new power supply, so most broken or used power supplies are replaced. Only experienced certified technicians should service power supplies.
- **Display monitors**: The internal electronic parts of a display monitor cannot be repaired, but they can be replaced. Monitors, especially CRT monitors, operate using high voltages. Only a certified electronic technician should service them.
- **Laser printers**: Laser printers can be very expensive. It is more cost effective to fix broken printers by repairing or replacing broken parts. Laser printers use high voltages and can have very hot surfaces inside. Use caution when servicing laser printers.

Figure 11-3 shows an example of a high-voltage warning sign.

Figure 11-3 High-Voltage Warning



Describe Environmental Issues

The Earth's environment is delicately balanced. The hazardous materials found in computer components must be disposed of in specific ways to help maintain this balance. A computer recycling warehouse is a place where discarded computer equipment can be taken apart. Computer parts that are still usable can be recycled for repairing other equipment.

Recycling warehouses must obey the codes and regulations for the disposal of each type of computer part. Before parts are recycled, they are separated into groups. CRT monitors contain as much as 4 to 5 lb. (1.6 to 2.3 kg) of lead, a dangerous element. Much of the lead is inside cathode ray tubes. Other materials inside computer equipment are also dangerous:

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- Mercury
- Cadmium
- Hexavalent chromium

Batteries are used to power laptop computers, digital cameras, camcorders, and remote-control toys. Batteries can contain some of these toxic materials:

- Nickel cadmium (Ni-Cd)
- Nickel metal hydride (Ni-MH)
- Lithium ion (Li-ion)
- Lead (Pb)

Many organizations have policies that define disposal methods for the hazardous components found in electronic equipment. These methods typically include programs to reuse, recycle, or exchange.

You might need to dispose of computer components because they have become outdated, or you might need additional functionality. In addition to recycling parts, you can donate them to other people or organizations. Some businesses exchange used computer equipment for partial payment of new equipment.

Describe Situations Requiring Replacement of Computer Components

Situations that require the replacement of computer components include the repair of broken parts or an upgrade for functionality.

After completing this section, you will meet these objectives:

- Select a case and power supply
- Select a motherboard
- Select a CPU and cooling system
- Select RAM
- Select adapter cards
- Select storage devices and hard drives
- Select input and output devices

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Select a Case and Power Supply

You should determine the customer's needs before making any purchases or performing upgrades. Ask your customer what devices will be connected to the computer and what applications will be used.

The computer case holds the power supply, motherboard, memory, and other components, as shown in Figure 11-4. When purchasing a new computer case and power supply separately, you should ensure that all the components will fit into the new case and that the power supply is powerful enough to operate all the components. Many times a case comes with a power supply inside. You still need to verify that the power supply provides enough power to operate all the components that will be installed in the case.

Figure 11-4 Computer Case and Power Supply



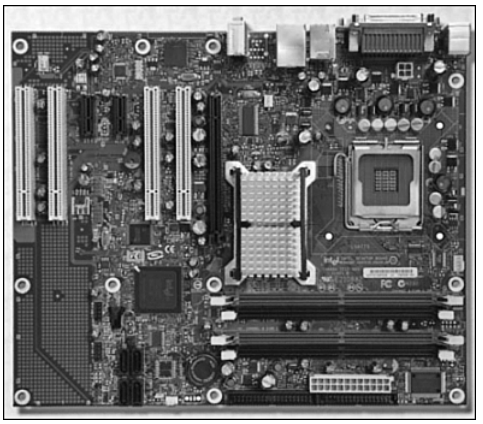
Select a Motherboard

New motherboards, as shown in Figure 11-5, often have new features or standards that can be incompatible with older components. When you select a replacement ***motherboard***, make sure that it supports the CPU, RAM, video adapter, and other adapter cards. The socket and chipset on the motherboard must be compatible with the CPU. The motherboard must also accommodate the existing heat sink/fan assembly.

The existing power supply must have connections that fit the new motherboard. Pay particular attention to the number and type of expansion slots. Determine whether they match the existing adapter cards. For example, the new motherboard might lack an Accelerated Graphics Port (AGP) connector for an existing video adapter. The motherboard might have PCI Express (PCIe) expansion slots that the existing adapter cards cannot use. Finally, the new motherboard must physically fit into the current computer case.

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Figure 11-5 Motherboard



Select the CPU and Heat Sink/Fan Assembly

Replace the CPU when it fails or is no longer adequate for the current applications. For example, you might have a customer who has purchased an advanced graphics application. The application might run poorly because it requires a faster processor than the current CPU.

Before you buy a CPU, make sure that it is compatible with the existing motherboard:

- The new CPU must use the same socket type and chipset.
- The BIOS must support the new CPU.
- The new CPU might require a different heat sink/fan assembly.

Manufacturers' websites are a good resource to investigate the compatibility between CPUs and other devices. When upgrading the CPU, make sure that the correct voltage is maintained. A voltage regulator module (VRM) is integrated into the motherboard. The voltage setting for the CPU can be configured with jumpers or switches located on the motherboard. Figure 11-6 shows two similar CPUs that use different sockets.

Select RAM

New ***random-access memory (RAM)*** might be needed when an application locks up or if the computer displays frequent error messages. To determine whether the problem is the RAM, replace the old RAM module, as shown in Figure 11-7. Restart the computer to see whether the application runs properly.

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Figure 11-6 Incompatible CPUs with Similar Capabilities

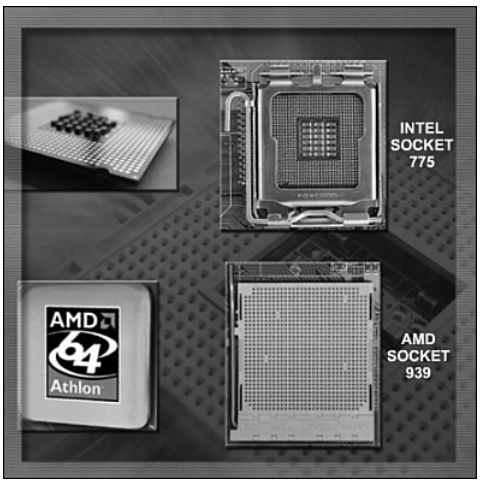
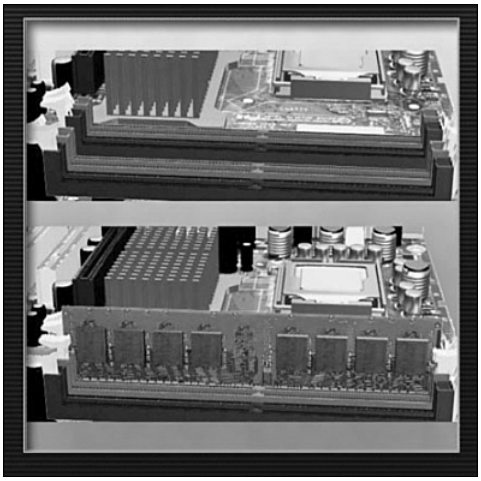


Figure 11-7 RAM Module



To close a stalled application, press Ctrl-Alt-Delete to open the Task Manager. In the window, select the application. Click **End Task** to close it, as shown in Figure 11-8.

When selecting new RAM, you must ensure that it is compatible with the current motherboard. It must also be the same type of RAM as installed in the computer. The speed of the new RAM must be the same or faster than the existing RAM. It can help to take the original memory module with you when you shop for the replacement RAM.

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Figure 11-8 Task Manager



Primary memory (RAM) is controlled by the OS. Bad RAM will show up in the power-on self test (POST) as not being counted. RAM will only need to be replaced when it is too slow or insufficiently large enough to accommodate the application. The OS will accommodate the application by increasing the virtual memory requirement, and hard disk thrashing will occur.

Select Adapter Cards

Adapter cards, also called expansion cards, add extra functionality to a computer. Figure 11-9 shows some of the adapter cards available. Before you purchase an adapter card, do some research:

- Is there an open expansion slot?
- Is the adapter card compatible with the open slot?

If the motherboard does not have compatible expansion slots, external devices can be an option:

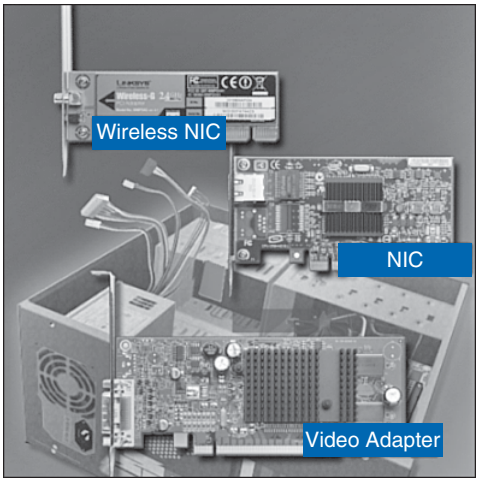
- Are USB or FireWire versions of the external device available?
- Does the computer have an open USB or FireWire port?

Consider the following situation for an adapter card upgrade. A customer requires a wireless card to connect to the network. The new wireless adapter card must be compatible with the existing wireless network and with the computer.

Investigate wireless network interface cards (NIC) before you purchase one. You should ensure that the new wireless NIC is compatible with the 802.11 wireless standard being used on the wireless network.

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Figure 11-9 Adapter Cards



Examine the computer for an available expansion slot or an open USB port. Purchase either an adapter card that will fit an available expansion slot or a USB wireless NIC. Cost, warranty, brand name, and availability are the last factors for you to consider.

Select Storage Devices and Hard Drives

You might need to replace a hard drive when it no longer meets your customer's needs for data storage or fails. The signs that a hard drive is failing include

- Unusual noises
- Error messages
- Corrupt data or applications

If your hard drive exhibits any of these symptoms, you should replace it as soon as possible. Figure 11-10 shows Parallel Advanced Technology Attachment (PATA), Serial Advanced Technology Attachment (SATA), and Small Computer System Interface (SCSI) connectors.

ATA was renamed Parallel ATA, or PATA, with the introduction of Serial ATA (SATA). PATA hard drives can use a 40-pin, 80-conductor cable or a 40-pin, 40-conductor cable.

SATA hard drives connect to the motherboard using a serial interface. SATA hard drives have a higher data-transfer rate than PATA drives. The smaller data cable allows improved airflow through the computer case. Early versions of SATA offered a speed of 1.5 Gbps. Current versions offer a speed of 3.0 Gbps.

The SCSI standard is typically used for hard drives and for tape storage. However, printers, scanners, CD-ROM drives, and DVD drives can also use SCSI. Today, SCSI devices are used mostly on servers or computers that require high transfer speeds and reliability.

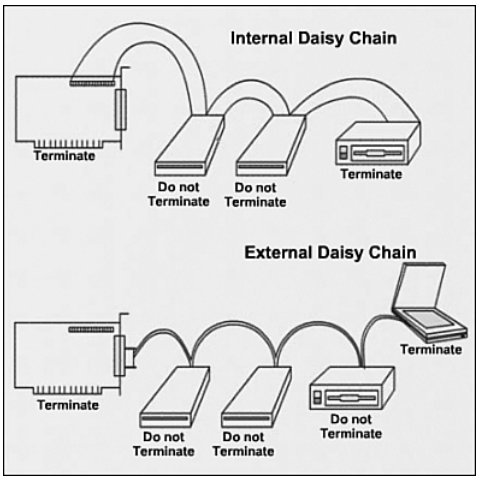
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Figure 11-10 Hard Drive Connectors



SCSI is a more advanced interface controller than PATA or SATA. It is ideal for high-end computers, including network servers. Devices can include hard drives, CD-ROM drives, tape drives, scanners, and removable drives. SCSI devices are typically connected in a series, forming a chain that is commonly called a daisy chain, as shown in Figure 11-11. Each end of the daisy chain must be terminated to prevent signals from bouncing off the ends of cables and causing interference. Generally, the SCSI controller on one end of the SCSI bus has on-board termination. The other end of the SCSI cable is either terminated by a resistor on the last drive on the chain or a physical terminator on the end of the SCSI bus.

Figure 11-11 SCSI Daisy Chain



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Most SCSI buses can handle a total of seven devices and a SCSI controller. The channels are numbered from 0 through 7. Some versions of SCSI support a total of 15 devices plus the SCSI controller. These channels are numbered 0 through 15. Each device on a SCSI channel must have a unique SCSI ID. For example, the primary drive would be 0 and the controller card is usually 7. The SCSI ID is generally set by jumpers on a SCSI drive.

The SCSI bus was originally 8 bits wide and operated at a transfer rate of 5 MBps. Later SCSI technologies used a 16-bit bus and operated at 320–640 MBps. Table 11-1 shows the different types of SCSIs. Current and future SCSI technologies use a serial interface for increased speed.

Table 11-1 SCSI Types

SCSI Type	Also Called	Connector	Maximum Throughput (MBps)
SCSI-1	—	50-pin	
Centronics 50-pin	5		
Fast SCSI	Plain SCSI	50-pin	
Centronics 50-pin	10		
Fast Wide SCSI	—	50-pin	
68-pin	20		
Ultra SCSI	Fast-20	50-pin	20
Ultra Wide SCSI	—	68-pin	40
Ultra2 SCSI	Fast-40	50-pin	40
Ultra2 Wide SCSI	—	68-pin	
80-pin	80		
Ultra3 SCSI	Ultra-160	68-pin	
80-pin	160		
Ultra320 SCSI	—	68-pin	
80-pin	320		

Narrow SCSI is 8 bits wide and Wide SCSI is 16 bits wide. Narrow SCSI uses 50-pin connectors and Wide SCSI uses 68-pin connectors. Internal connections use 80-pin connectors.

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Select Input and Output Devices

An input device can be any piece of equipment that transfers information into a computer:

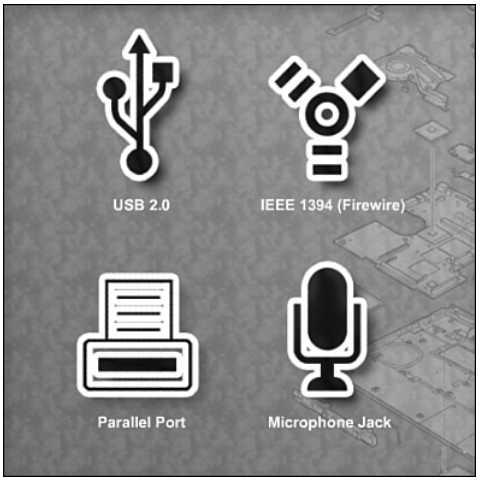
- Mouse
- Keyboard
- Scanner
- Camera
- Process control sensor
- MIDI interface
- Microphone

An output device transfers information to the outside of the computer:

- Display monitor
- Projector
- Printer
- Process-control equipment
- Speaker

To select input and output devices, you should first find out what the customer wants. Next, you should select the hardware and software by researching the Internet for possible solutions. After you determine which input or output device the customer needs, you must determine how to connect it to the computer. Figures 11-12 shows common input and output port symbols.

Figure 11-12 Common Input and Output Port Symbols



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Technicians should have a good understanding of several types of interfaces:

- **USB 1.1**: Transfers data at a maximum speed of 12 Mbps.
- **USB 2.0**: Transfers data at a maximum speed of 480 Mbps.
- **IEEE 1394 (FireWire)**: Transfers data at 100, 200, or 400 Mbps.
- **Parallel (IEEE 1284)**: Transfers data at a maximum speed of 3 Mbps.
- **Serial (RS-232)**: Early versions were limited to 20 kbps, but newer versions can reach transfer rates of 1.5 Mbps.
- **SCSI (Ultra-320 SCSI)**: Connects as many as 15 devices with a transfer rate of 320 Mbps.



Worksheet 11.3.7: Research Computer Components

In this worksheet, you research computer components. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this worksheet now or wait until the end of the chapter.

Upgrade and Configure Personal Computer Components and Peripherals

Computer systems need periodic upgrades for various reasons:

- User requirements change.
- Upgraded software packages require new hardware.
- New hardware offers enhanced performance.

Changes to the computer can cause you to upgrade or replace components and peripherals. You should research the effectiveness and cost for both options: upgrading and replacing.

After completing this section, you will meet these objectives:

- Upgrade and configure a motherboard
- Upgrade and configure a CPU and a heat sink/fan assembly
- Upgrade and configure RAM
- Upgrade and configure BIOS
- Upgrade and configure storage devices and hard drives
- Upgrade and configure input and output devices

Figure 11-13 shows some of the different components and peripherals to upgrade.

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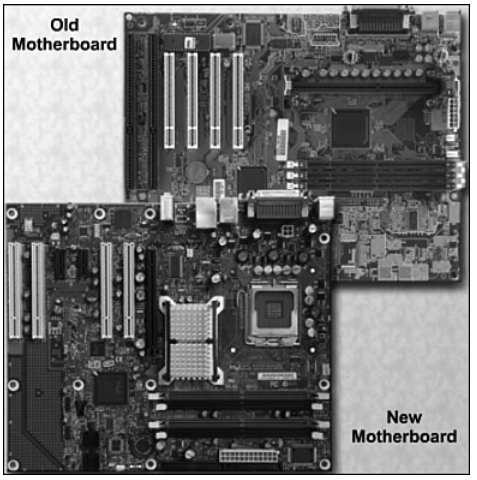
Figure 11-13 Upgrade or Replace



Upgrade and Configure a Motherboard

To upgrade or replace a motherboard, you might have to replace several other components, such as the CPU, heat sink/fan assembly, and RAM. Figure 11-14 shows an example of an old motherboard and a replacement/new motherboard.

Figure 11-14 Motherboards



A new motherboard must fit into the old computer case. The power supply must also be compatible with the new motherboard and be able to support all new computer components.

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You should begin the upgrade by moving the CPU and heat sink/fan assembly to the new motherboard. These are much easier to work with when they are outside of the case. You should work on an antistatic mat and wear a wrist strap to avoid damaging the CPU. Remember to use thermal compound between the CPU and the heat sink. If the new motherboard requires different RAM, install it at this time.

When it is time to remove and replace the old motherboard, remove the cables from the motherboard that attach to the case LEDs and buttons. They can have the same labels, but there might be minor differences. Make the appropriate notes in your journal to know where and how everything is connected before you start the upgrade.

Note how the motherboard secures to the case. Some mounting screws provide support, and some can provide an important grounding connection between the motherboard and chassis. In particular, you should pay attention to screws and standoffs that are nonmetallic. These can be insulators. Replacing insulating screws and supports with metal hardware that conducts electricity can have disastrous results.

Make sure that you use the correct screws. Do not swap threaded screws with self-tapping metal screws; they will damage the threaded screw holes and might not be secure. Make sure that threaded screws are the correct length and have the same number of threads per inch. If the thread is correct, they will fit easily. You can make a screw fit by using force, but you will damage the threaded hole and the screw will not hold the motherboard securely. Using the wrong screw can also produce metal shavings that can cause short circuits.

Note

It does not matter whether you replace a flat head screw with a Phillips head screw, as long as the threaded part of the screw is the same length and has the same number of threads.

Next you should connect the power supply cables. If the Advanced Technology eXtended (ATX) power connectors are not the same size (some have more pins), you might need to use an adapter. Connect the cables for the case LEDs and buttons.

After the new motherboard is in place and cabled, you should install and secure all expansion cards. Check your work. Make sure that there are no loose parts or leftover wires. Connect a keyboard, mouse, monitor, and power. If there is any sign of trouble, you should shut the power supply off immediately.

Do not forget that an expansion card can have the same functionality that is integrated into the motherboard. In this case, you might need to disable the on-board functions in the system BIOS. Use the documentation that came with the motherboard to learn what BIOS adjustments might be required.

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Lab 11.4.1: Install a NIC

In this lab, you install a NIC and disable an integrated motherboard network adapter. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Upgrade and Configure a CPU and a Heat Sink/Fan Assembly

One way to increase the apparent power of a computer is to increase the processing speed. You can often do this by upgrading the ***central processing unit (CPU)***. However, there are some requirements that you must meet:

- The new CPU must fit into the existing CPU socket.
- The new CPU must be compatible with the motherboard chipset.
- The new CPU must operate with the existing motherboard and power supply.
- The new CPU must operate with the existing RAM. The RAM might need to be upgraded or expanded to take advantage of the faster CPU.

If the motherboard is older, you might not be able to find a compatible CPU. In that case, you would replace the motherboard.

Caution

Always work on an antistatic mat and wear a wrist strap when installing and removing CPUs. Place a CPU on the antistatic mat until you are ready to use it. Store CPUs in antistatic packaging.

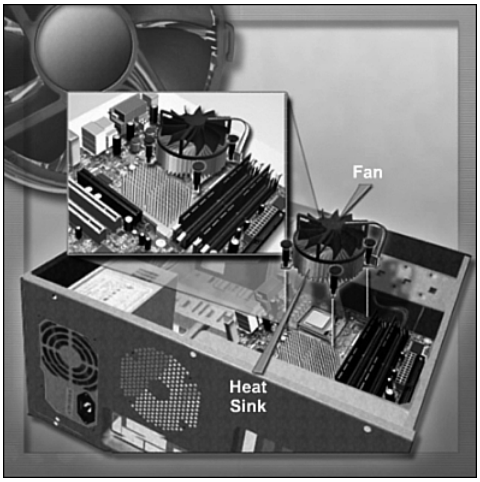
To change the CPU, you should remove the existing CPU by releasing it from the socket using the zero insertion force (ZIF) lever. Different sockets have slightly different mechanisms, but all serve to lock the CPU in place after it is correctly oriented in the socket.

Insert the new CPU into place. Do not force the CPU into its socket, or use excessive force to close the locking bars. Excessive force can damage the CPU or its socket. If you encounter resistance, make sure that you have aligned the CPU properly. Most have a pattern of pins that will fit only one way. If there is a question, examine the new CPU to ensure that it is physically similar to the old one.

The new CPU might require a different heat sink/fan assembly. The heat sink/fan assembly, as shown in Figure 11-15, must physically fit the CPU and be compatible with the CPU socket. The heat sink/fan assembly must also be adequate to remove the heat of the faster CPU.

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Figure 11-15 CPU and Heat Sink/Fan Assembly



Note

You must apply thermal compound between the new CPU and the ***heat sink/fan*** assembly. This is because the surface of the heat sink and CPU is not entirely flat, and if you place the heat sink directly on the CPU, there might be gaps that you cannot see. Air conducts heat poorly, and the gaps have a negative effect on heat transfer. By applying a thermal compound that has a high thermal conductivity, you improve the heat conductivity between the heat sink and CPU.

With some types of BIOS, you can view thermal settings to determine whether there are any problems with the CPU and the heat sink/fan assembly. Third-party software applications can report CPU temperature information in an easy-to-read format. Refer to the motherboard or CPU user documentation to determine whether the chip is operating in the correct temperature range. Some CPU and case fans turn on and off automatically depending on the CPU temperature and the internal case temperature. The temperatures are measured through thermal probes built into the fan assembly, or internal circuitry in the CPU.

Upgrade and Configure RAM

Increasing the amount of system RAM almost always improves overall system performance. Prior to upgrading or replacing the RAM, there are some questions you must answer:

- What type of RAM does the motherboard currently use?
- Can the RAM be installed one module at a time, or should it be grouped into matching banks?
- Are there any available RAM slots?
- Does the new RAM chip match the speed, latency, type, and voltage of the existing RAM?

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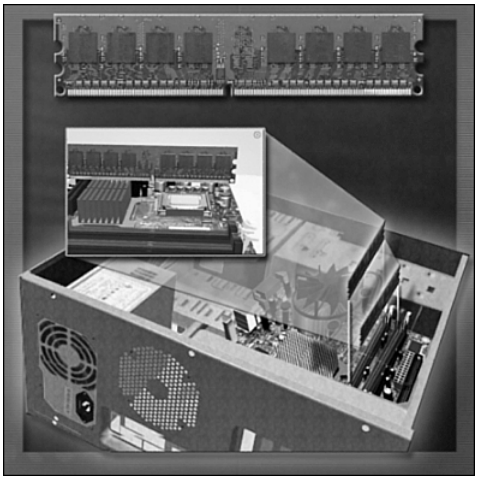
Caution

When working with system RAM, work on an antistatic mat and wear a wrist strap. Place the RAM on the mat until you are ready to install it. Store RAM in antistatic packaging.

Remove the existing RAM by freeing retaining clips that secure it. Pull it from the socket. Current dual-inline memory modules (DIMM) pull straight out and insert straight down. Earlier single-inline memory modules (SIMM) were inserted at an angle to lock into place.

Insert the new RAM, as shown in Figure 11-16, and lock it into place with the retaining clips.

Figure 11-16 Installing RAM



Caution

Make sure to insert the memory module completely into the socket. RAM can cause serious damage to the motherboard if it is incorrectly aligned and shorts the main system bus.

The system discovers the newly installed RAM if it is compatible and installed correctly. If the BIOS does not indicate the presence of the correct amount of RAM, check to make sure that the RAM is compatible with the motherboard and is correctly installed.

Lab 11.4.3: Install Additional RAM

In this lab, you install additional RAM in the computer. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

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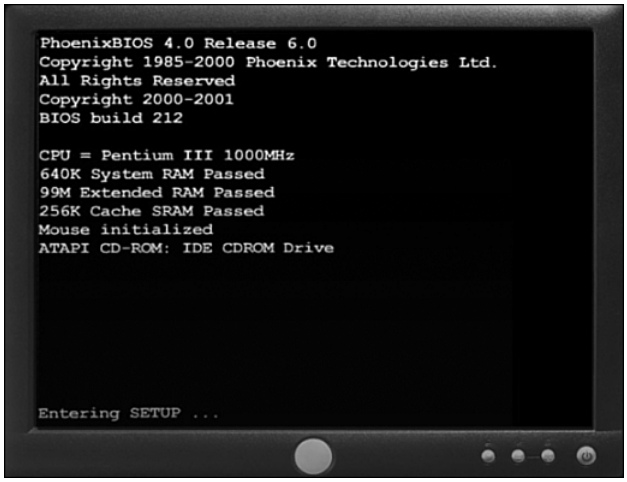
Upgrade and Configure BIOS

Motherboard manufacturers periodically release updates for their ***basic input/output system (BIOS)***. The release notes describe the upgrade to the product, compatibility improvements, and the known bugs that have been addressed. Some newer devices only operate properly with an updated BIOS.

Early computer BIOS information was contained in ROM chips. To upgrade the BIOS information, the ROM chip had to be replaced, which was not always possible. Modern BIOS chips are EEPROM, or flash memory, which can be upgraded by the user without opening the computer case. This process is called *flashing the BIOS*.

To view the current BIOS settings on your computer, you must enter the BIOS setup program as shown in Figure 11-17. Press the setup sequence keys while the computer is performing the POST. Depending on the computer, the setup key might be **F1**, **F2**, or **Delete**. Watch the text on the screen or consult the motherboard manual to find the setup key or combination of keys.

Figure 11-17 BIOS Version



The first part of the boot process displays a message that tells you which key to press to enter the setup, or BIOS, mode. There are a variety of settings in the BIOS that should not be altered by anyone unfamiliar with this procedure. If you are unsure, it is best not to change any BIOS setting unless you research the problem in depth.

To download a new BIOS, consult the manufacturer's website and follow the recommended installation procedures. Installing BIOS software online can involve downloading a new BIOS file, copying or extracting files to a floppy disk, and then booting from the floppy. An installation program prompts the user for information to complete the process. Some newer programs will do a BIOS update without the need to create a floppy disk. The BIOS will be updated after you reboot your computer.

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Although it is still common to flash the BIOS through a command prompt, several motherboard manufacturers provide software on their websites that allow a user to flash the BIOS from within Windows. The procedure varies from manufacturer to manufacturer.

Caution

An improperly installed or aborted BIOS update can cause the computer to become unusable.



Lab 11.4.4: BIOS File Search

In this lab, you search for newer BIOS versions. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Upgrade and Configure Storage Devices and Hard Drives

Instead of purchasing a new computer to get increased access speed and storage space, you can consider adding another hard drive. There are several reasons for installing an additional drive:

- To install a second operating system
- To provide additional storage space
- To provide a faster hard drive
- To hold the system swap file
- To provide a backup for the original hard drive
- To increase fault tolerance

If the new drive is PATA and is on the same data cable, one of the drives must be set as the master drive and the other must be set as the slave drive. Figure 11-18 shows jumper settings on the back of a PATA hard drive. Also, any new partitions or drive letter assignments should be well planned. The boot order in the BIOS might need to be adjusted.

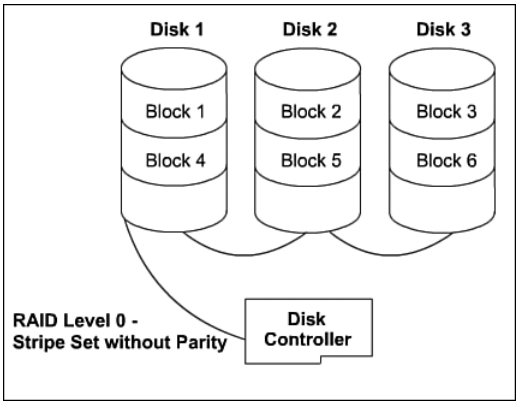
Figure 11-18 Hard Drive Jumper Settings



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Arrays, such as a Redundant Array of Independent Disks (RAID), improve fault tolerance when connecting multiple hard drives, as shown in Figure 11-19. Some types of RAID require two or more hard drives. You can install RAID using hardware or software. Hardware installations are usually more dependable but are more expensive. Software installations are created and managed by an operating system, such as Windows Server 2003.

Figure 11-19 Types of RAID



Lab 11.4.5: Install, Configure, and Partition a Second Hard Drive

In this lab, you install and configure a second hard drive. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Upgrade and Configure Input and Output Devices

If an input or output device stops operating, you might have to replace the device. Some customers might want to upgrade their input or output devices to increase performance and productivity.

An ergonomic keyboard, shown in Figure 11-20, can be more comfortable to use. Sometimes a reconfiguration is necessary to enable a user to perform special tasks, such as typing in a second language with additional characters. Finally, replacing or reconfiguring an input or output device can make it easier to accommodate users with disabilities.

Sometimes it is not possible to perform an upgrade using the existing expansion slots or sockets. In this case, you might be able to accomplish the upgrade using a USB connection. If the computer does not have an extra USB connection, you must install a USB adapter card or purchase a USB hub, as shown in Figure 11-21.

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Figure 11-20 Ergonomic Wireless Keyboard and Mouse



Figure 11-21 USB Hub



After obtaining new hardware, you might have to install new drivers. You can usually do this by using the installation CD. If you do not have the CD, you can obtain updated drivers from the website of the manufacturer.

Note

A signed driver is a driver that has passed the Windows hardware quality lab test and has been given a driver signature by Microsoft. Installing an unsigned driver can cause system instability, error messages, and boot problems. During hardware installation, if an unsigned driver is detected, you will be asked whether you want to continue installation of this driver.

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Identify and Apply Common Preventive Maintenance Techniques for Personal Computer Components

To keep computers working properly, you must maintain them by performing preventive maintenance. Preventive maintenance can extend the life of the components, protect data, and improve computer performance.

After completing this section, you will meet these objectives:

- Clean internal components
- Clean the case
- Inspect computer components

Clean Internal Components

One important part of computer preventive maintenance is to keep the system clean. The amount of dust in the environment and the habits of the user determine how often to clean the computer components. Most of your cleaning is to prevent the accumulation of dust.

To remove dust, do not use a vacuum cleaner. Vacuum cleaners can generate static and can damage or loosen components and jumpers. Instead, you should use compressed air to blow the dust away. If you use compressed air from a can, keep the can upright to prevent the fluid from leaking onto computer components. Always follow the instructions and warnings on the compressed air can.

Regular cleaning also gives you a chance to inspect components for loose screws and connectors. There are several parts inside the computer case that you should keep as clean as possible:

- Heat sink/fan assembly
- RAM
- Adapter cards
- Motherboard
- Case fan
- Power supply
- Internal drives

Caution

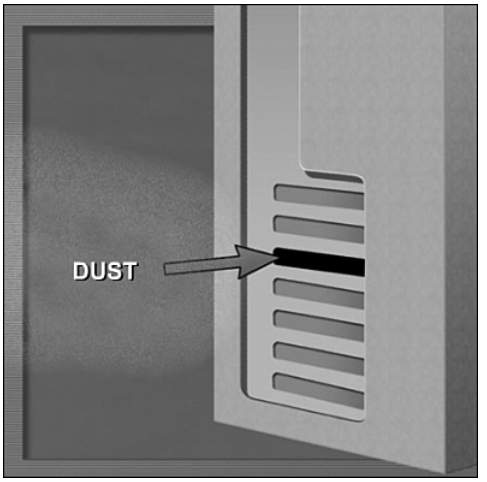
When you clean a fan with compressed air, hold the fan blades in place. This prevents overspinning the rotor or moving the fan in the wrong direction.

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Clean the Case

Dust or dirt on the outside of a computer can travel through cooling fans and loose computer case covers. Dirt can also enter a computer through missing expansion slot covers, as shown in Figure 11-22. If dust accumulates inside the computer, it can prevent the flow of air and affect cooling.

Figure 11-22 Cleaning the Computer Case



Use a cloth or duster to clean the outside of the computer case. If you use a cleaning product, do not spray it directly on the case. Instead, put a small amount onto a cleaning cloth or duster and wipe the outside of the case.

While cleaning the case, you should look for and correct things that might cause a problem later:

- Missing expansion slot covers that let dust, dirt, or living pests into the computer
- Loose or missing screws that secure adapter cards
- Missing or tangled cables that can pull free from the case

Inspect Computer Components

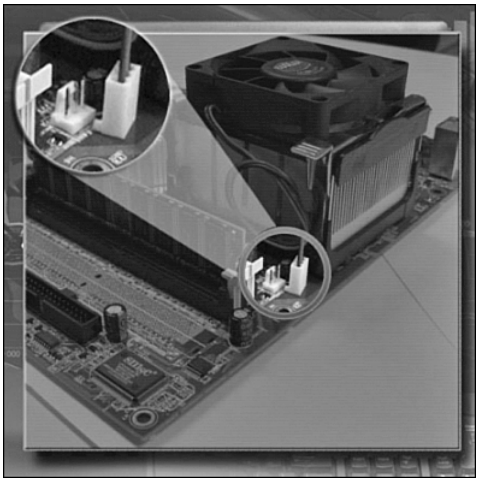
The best method of keeping a computer in good condition is to examine the computer on a regular schedule. Cleaning provides a good opportunity to make this inspection. You should have a checklist of components to inspect, as described in the following sections.

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CPU and Cooling System

Examine the CPU and cooling system for dust buildup. Make sure that the fan can spin freely. Check that the fan power cable is secure, as shown in Figure 11-23. Check the fan while the power is on to see the fan turn. Inspect the CPU to be sure that it is seated securely in the socket. Make sure that the heat sink is well attached. To avoid damage, do not remove the CPU for cleaning.

Figure 11-23 Loose Heat Sink/Fan Assembly Connector



RAM Connections

The RAM chips, as shown in Figure 11-24, should be seated securely in the RAM slots. Sometimes the retaining clips can loosen. Reseat them, if necessary. Use compressed air to remove any dust.

Storage Devices

Inspect all storage devices including the hard drives, floppy drive, optical drives, and tape drive. All cables should be firmly connected. Check for loose, missing, or incorrectly set jumpers, as shown in Figure 11-25. A drive should not produce rattling, knocking, or grinding sounds. Read the manufacturer's manual to learn how to clean optical drive and tape heads by using cotton swabs and compressed air. Clean floppy drives with a drive cleaning kit.

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Figure 11-24 RAM Chips

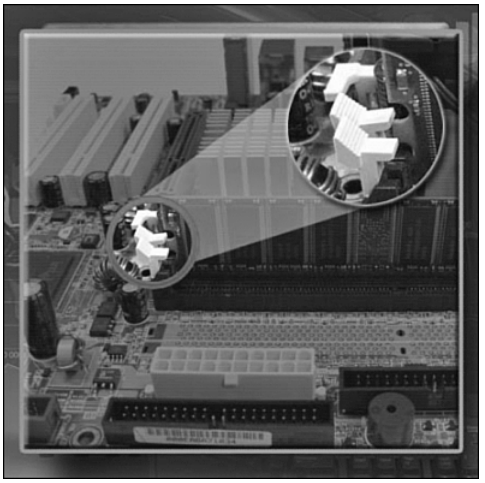
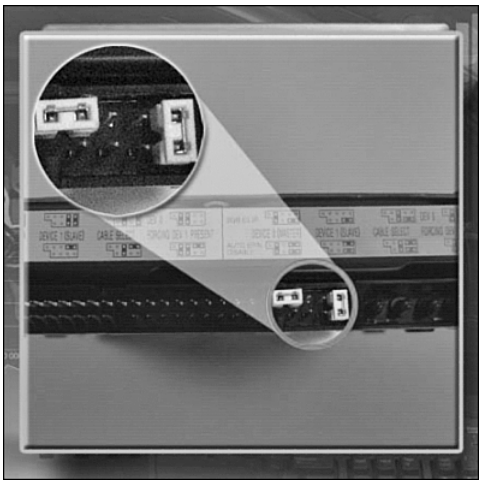


Figure 11-25 Hard Drive Jumpers

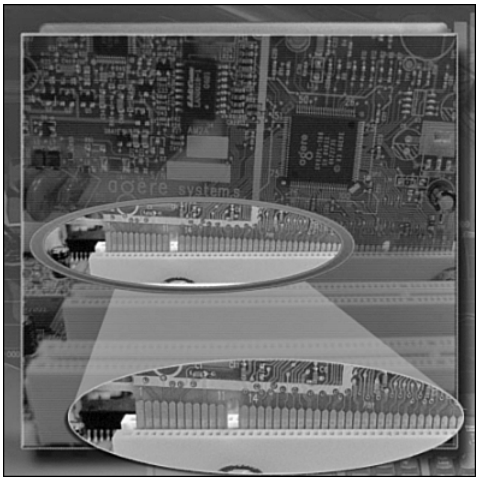


Adapter Cards

Adapter cards should be seated properly in their expansion slots. Loose cards, as shown in Figure 11-26, can cause short circuits. Secure adapter cards with the retaining screw to avoid the cards coming loose in their expansion slots. Use compressed air to remove any dirt or dust on the adapter cards or the expansion slots.

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Figure 11-26 Loose Adapter Card



Note

The video adapter can sometimes become unseated because the large monitor cable can put pressure on it, or it is mishandled when someone is tightening the retainer screws. If a video adapter is used in an expansion slot, the integrated video adapter from the motherboard is likely to be disabled. If you connect a monitor to it in error, the computer appears not to work.

Power Devices

Inspect power strips, surge suppressors (surge protectors), and uninterruptible power supply (UPS) devices. Make sure that there is proper and unobstructed ventilation. Replace the power strip if there have been electrical problems or excessive thunderstorms in the area.

Loose Screws

Loose screws can cause problems if they are not immediately fixed or removed. A loose screw in the case can later cause a short circuit or can roll into a position where the screw is hard to remove.

Keyboard and Mouse

Use compressed air or a small vacuum cleaner to clean the keyboard and mouse. If the mouse is the mechanical type, remove the ball and clean off any dirt.

Cables

Examine all cable connections. Look for broken and bent pins. Ensure that all connector retaining screws are finger tight. Make sure cables are not crimped, pinched, or severely bent.

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Troubleshoot Computer Components and Peripherals

The troubleshooting process helps resolve problems with the computer or peripherals. These problems range from simple, such as updating a drive, to more complex problems, such as installing a CPU. Use the troubleshooting steps as a guideline to help you diagnose and repair problems.

After completing the following sections, you will meet these objectives:

- Review the troubleshooting process
- Identify common problems and solutions
- Apply troubleshooting skills

Review the Troubleshooting Process

Computer technicians must be able to analyze the problem and determine the cause of the error to repair the computer. This process is called *troubleshooting*.

The first step in the troubleshooting process is to gather data from the customer.

Ask the customer open-ended questions about computer errors. Examples are shown in the following list. (This list is *not* comprehensive.)

- Can you describe precisely what happens when the computer boots?
- How often does the computer fail to start?
- What is the first screen you see when you turn on your computer?
- What sound does the computer make as it starts?
- Is there a pause, or does the computer restart instantly?

Also ask the customer closed-ended questions about computer errors. (This list is *not* comprehensive.)

- Has anyone done any repair work on the computer recently?
- Has anyone else used the computer?
- Does this computer have a floppy drive?
- Does this computer have a USB drive installed?
- Is there a wireless NIC in this computer?
- Is the computer turned off at night?
- Is the computer secured in a locked room at night?
- Do you have a Windows XP installation CD on hand?

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After you have talked to the customer, you should verify the obvious issues. Issues that apply to computer hardware include the following:

- Are all the cables to this computer tightly in their sockets?
- Is the power cord firmly seated at both ends?
- Is the cable that connects the computer to the monitor squarely seated in its socket with the thumbscrews finger tight?
- Are any of the rear-panel expansion-slot covers loose so that the adapter cards could have loosened?
- Was the computer recently dropped or jarred?
- Are there any missing screws or signs that the computer has been tampered with?

After you have verified the obvious issues, try some quick solutions to computer hardware problems:

- Check the external cables for loose connections that could cause a restart.
- Check the internal data and power cables for loose connections.
- Ensure that adapter cards and RAM are properly secured.
- Verify that all cooling fans are operating properly.

If quick solutions did not correct the problem, it is time to gather data from the computer. Some different ways to gather information about the problem from the computer include the following:

- You cannot access Safe Mode from the startup menu.
- The computer boots from a Windows startup disk.
- You can access the hard drive.

At this point, you have enough information to evaluate the problem and research and implement possible solutions. When researching possible solutions for a problem, use the following sources of information:

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals

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- Online forums
- Technical websites

After you have solved the problem, close with the customer. Tasks required to complete this step include the following:

- Discuss the solution implemented with customer.
- Have the customer verify that the problem has been solved.
- Provide the customer with all paperwork.
- Document steps taken to solve the problem in the work order and the technician's journal.
- Document any components used in the repair.
- Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Computer problems can be attributed to hardware, software, networks, or some combination of the three. You will resolve some types of computer problems more often than others. Table 11-2 is a chart of common hardware problems and solutions.

Table 11-2 Common Problems and Solutions

Problem Symptom	Possible Solution
Sound card does not work	Turn off the integrated audio on the motherboard using the BIOS setup program.
Cannot use SCSI drive	Check SCSI IDs for duplicates.
Cannot detect drive after bootup	Check and reseat power cable.
System does not start after installing new processor	Reseat processor, verify motherboard compatibility with the BIOS version and the CPU, and flash the BIOS.
Cannot use external SCSI drive	Turn on the drive before booting computer.
System runs for a few minutes and then locks up	Check fan power cable, verify fan operation, and verify that thermal compound is properly applied.

Apply Troubleshooting Skills

Now that you understand the troubleshooting process, it is time to apply your listening and diagnostic skills.

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Lab 11.6.3 is designed to reinforce your skills with PC hardware problems. You will troubleshoot and repair a computer that does not boot.

Remote Technician 11.6.3 is designed to reinforce your communication and troubleshooting skills with PC hardware problems. In this lab, you will perform the following steps:

- Receive the work order
- Take the customer through various steps to try and resolve the problem
- Document the problem and the resolution



Lab 11.6.3: Repair Boot Problem

In this lab, you repair a computer boot problem. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.



Remote Technician 11.6.3: Repair Boot Problem

In this activity, you instruct a customer on how to repair a computer boot problem. Refer to the activity in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this now or wait until the end of the chapter.

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Summary

In this chapter, you learned about advanced computer diagnosis and repair and found out how to consider upgrades and select components. This chapter also presented some detailed troubleshooting techniques to help you locate and resolve problems, and present your findings to the customer. A summary of the topics is as follows:

- You learned about the roles of the field, remote, and bench technicians and the job possibilities that are available to those who enter the work force with some knowledge of advanced troubleshooting skills.
- You can explain and perform safe lab procedures and tool use. You can describe basic electrical safety, especially as it applies to monitors and laser printers. You understand the purpose and enforcement of worker safety standards.
- You know the safe disposal procedures for various types of computer batteries and types of hardware, such as monitors.
- You can advise customers how to protect their computers by using good preventive maintenance practices.
- You can describe ways to clean the external components of a computer, including the monitor, case, printer, and peripherals. You can describe how to clean internal components of a computer, such as the motherboard, CPU and cooling system, RAM, and adapter cards.
- You know how to advise customers when it is best to upgrade a computer and components and when it is best to buy new products.
- You can explain the steps involved in adding and configuring a second hard drive. You can describe the steps involved in updating various computer components, such as cases, power supplies, the CPU and cooling system, RAM, hard drives, and adapter cards.
- You can demonstrate the use of open- and closed-ended questions that are appropriate for a level-two technician to determine the problem.
- You can describe the troubleshooting steps, including gathering data from the customer, verifying obvious issues, trying quick solutions first, evaluating problems, and implementing solutions until the problem is fixed.
- You have an understanding of the role of the level-two technician, and you know how to build on the troubleshooting efforts of a level-one technician.

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Summary of Exercises

This is a summary of the Labs, Worksheets, and Remote Technician exercises associated with this chapter.



Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Lab 11.4.1: Install a NIC

Lab 11.4.3: Install Additional RAM

Lab 11.4.4: BIOS File Search

Lab 11.4.5: Install, Configure, and Partition a Second Hard Drive

Lab 11.6.3: Repair Boot Problem



Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Worksheet 11.1.0: Job Opportunities

Worksheet 11.3.7: Research Computer Components



Remote Technician Activity

The following activity covers material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Remote Technician 11.6.3: Repair Boot Problem

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Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Computer components should be disposed of properly to meet state and federal standards. Which of the following dangerous materials can be found in computer components? (Choose three.)

   a. Cadmium
   b. Carbon
   c. Hydrogen
   d. Lead
   e. Mercury
   f. Nitrogen

2. A technician has been called to troubleshoot a computer. The user reports that the computer has become louder during use and programs are slow to load. Which component is most likely beginning to fail?

   a. CPU
   b. Hard drive
   c. Memory
   d. Floppy drive

3. Which of the following devices should not be repaired while using antistatic devices? (Choose two.)

   a. Hard drive
   b. Memory
   c. Modem
   d. Monitor
   e. Power supply

4. Which of the following peripherals would be considered output devices? (Choose three.)

   a. Camera
   b. Display monitor
   c. Keyboard
   d. Microphone
   e. Projector
   f. Speaker

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5. What is a safety concern that technicians need to remember when working on a CRT?

   a. Risk of chemical burns
   b. Risk of electrical shock
   c. Risk of phosphor contamination
   d. Risk of lead poisoning

6. A user has moved to a different location on the same campus. The network media is different at the new location. Which of the following considerations will affect the choice of the replacement NIC? (Choose two.)

   a. Availability of expansion slot
   b. Type of memory
   c. Network protocols used in the new location
   d. Type of hard drive
   e. Type of lighting

7. While performing regular maintenance on a computer, a technician notices that the NIC is loose in an expansion slot. What is the proper course of action?

   a. Replace the NIC with a new card.
   b. Use thermal paste to secure the card in the expansion slot.
   c. Secure the adapter card in the expansion slot and tighten the retaining screw.
   d. The slot is most likely damaged. Use a new slot if one is available.

8. Which activity increases the chance of computer components becoming damaged from ESD?

   a. Touching the metal case before working on a computer
   b. Walking across a carpet or a rug and touching components
   c. Using antistatic mats when working with components
   d. Using nonmagnetic tools when working on a computer

9. Which of the following causes can affect the correct flow of air and lead to a computer overheating? (Choose two.)

   a. Two case fans: one pulling and one pushing
   b. Missing expansion slot cover
   c. Dust buildup around fans and air vents
   d. Heat sink added to the Northbridge chipset
   e. Missing slot coolers

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10. As an on-site technician, you have been given the assignment of replacing a damaged motherboard on a customer's computer. You will need to transport the motherboard to the residence. Which is the best method to carry the motherboard?

a. Wrap the motherboard in a piece of lint-free cloth.

b. Carry the motherboard in an antistatic bag.

c. Carry the motherboard in a metal-lined plastic box.

d. Carry the motherboard in a paper bag.

11. Which of the following actions should you *not* perform if you want to prevent your computer from any type of ESD while servicing the computer? (Choose two.)

a. Wear an antistatic wrist band.

b. Keep one hand in contact with the bare metal frame of the computer at all times.

c. Make sure that the room in which the computer is serviced is carpeted.

d. Make sure that the room in which the computer is serviced is cool and dry.

e. Do not wear cotton clothes.

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CHAPTER 12

Advanced Operating Systems

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- How can I select the appropriate operating system based on customer needs?
- What is the best way to install, configure, and optimize an operating system?
- How do I upgrade operating systems?
- What are the preventive maintenance procedures for operating systems?
- How do I troubleshoot operating systems?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

operating system *page xx*

network operating system (NOS) *page xx*

redundant storage systems *page xx*

default installation *page xx*

custom installation *page xx*

unattended installation *page xx*

image-based installation *page xx*

remote installation *page xx*

Disk Management *page xx*

virtual memory *page xx*

swap file *page xx*

Disk Defragmenter *page xx*

temporary files *page xx*

dual-boot setup *page xx*

restore points *page xx*

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The installation, configuration, and optimization of operating systems are examined in greater detail in this chapter.

There are various brands of operating systems available on the market today, including Microsoft Windows, Apple Mac OS, UNIX, and Linux. A technician must consider the current computer system when selecting an operating system. Additionally, there are several versions or distributions of an operating system. Some versions of Microsoft Windows include Windows 2000 Professional, Windows XP Home Edition, Windows XP Professional, Windows Media Center, Windows Vista Home Basic, Windows Vista Business, and Windows Vista Premium.

Each of these operating systems offers many of the same features with a similar interface. However, some functions necessary for specific customer needs might not be available in all of them. You must be able to compare and contrast operating systems to find the best one based on your customer's needs.

Select the Appropriate Operating System Based on Customer Needs

There are many operating systems to choose from, each with features that should be considered when consulting with a customer. When selecting an operating system for a customer, you should select hardware that meets or exceeds the minimum requirements for equipment called for by the operating system.

In this chapter, Windows XP Professional is used to describe the functions of an operating system. At some point during your career, you will most likely upgrade or repair a computer with a Windows operating system.

Table 12-1 shows a comparison of Windows operating systems.

Table 12-1 Windows OS Features

	Remote Desktop?	Network Sharing?	Scalable CPU Support?	Encrypted File System (EFS) Support?	Enhanced Security?
Microsoft Windows XP Professional	Yes	Yes	Yes	Yes	Yes
Microsoft Windows XP Home Edition	No	Yes	No	No	No
Microsoft Windows XP Media Center Edition	Yes	Yes	Yes	Yes	Yes
Microsoft Windows 2000	Add-On	Yes	Yes	Yes	Yes

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After completing this section, you will meet these objectives:

- Describe operating systems
- Describe network operating systems

Describe Operating Systems

An ***operating system*** is the interface between the user and the computer. Without an operating system, the user would not be able to interact with the hardware or software on the computer. An operating system provides the following operational and organizational capabilities:

- Provides a bridge between the hardware and applications
- Creates a file system to store data
- Manages applications
- Interprets user commands

Operating systems have minimum requirements for hardware. Table 12-2 shows the minimum hardware requirements for several operating systems.

Table 12-2 OS Hardware Requirements

Hardware	Windows XP	Mac OS X	Linux	UNIX
CPU	Intel Pentium/ Celeron family, AMD K6/Athlon/ Duron family, or compatible; single- or dual-processor system; 300 MHz or higher	PowerPC G3, G4, or G5 processor	486 or greater processor	PA-RISC 1.1, PA-RISK 2.0, Sun SPARC Ultra 1, or higher; Pentium II 233 MHz or higher (32-bit); Tru64 CPU Alpha processor (64-bit); PowerPC processor
Minimum RAM (MB)	128	256	32	64
Minimum hard disk space (GB)	1.5	3.0	3.5	1.0

continues

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Table 12-2 OS Hardware Requirements *continued*

Hardware	Windows XP	Mac OS X	Linux	UNIX
Display	Super VGA (800 x 600) or higher resolution video adapter and monitor	Built-in display or Apple-supplied video card supported by your computer	—	—
CD	CD-ROM or DVD drive	DVD drive	—	—
Human interface	Keyboard and Microsoft mouse or compatible pointing device	—	—	—
I/O	—	Built-in FireWire	—	—
Floppy drive	—	—	3.5-inch	—

Describe Network Operating Systems

A ***network operating system (NOS)*** is an operating system that contains additional features to increase functionality and manageability in a networked environment. The following are examples of network operating systems:

- Windows 2000 Server
- Windows 2003 Server
- UNIX
- Linux
- Novell NetWare
- Mac OS X

The NOS is designed to provide network resources to clients:

- Server applications, such as shared databases
- Centralized data storage
- Directory services that provide a centralized repository of user accounts and resources on the network, such as Lightweight Directory Access Protocol (LDAP) or Active Directory
- Network print queue

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- Network access and security
- ***Redundant storage systems***, such as Redundant Array of Inexpensive Disks (RAID) and backups

Network operating systems provide several protocols designed to perform network functions. These protocols are controlled by code on the network servers. Protocols used by network operating systems provide services such as web browsing, file transfer, e-mail, name resolution, and automatic IP addressing. Network protocols include

- **HTTP (Hypertext Transport Protocol)**: Defines how files are exchanged on the web
- **FTP (File Transfer Protocol)**: Provides services for file transfer and manipulation
- **POP (Post Office Protocol)**: Retrieves e-mail messages from an e-mail server
- **DNS (Domain Name System)**: Resolves URLs for websites with their IP addresses
- **DHCP (Dynamic Host Control Protocol)**: Automates assignment of IP addresses

Install, Configure, and Optimize an Operating System

Most operating systems are easy to install. After the computer starts, the Windows XP Professional installation CD displays a wizard, as shown in Figure 12-1, to guide you through the installation process with a series of questions. After the answers to the questions are provided, the installation wizard completes the installation automatically. In the following sections, you will perform a custom installation of Windows XP Professional.

Figure 12-1 Windows XP Installation



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After completing this section, you will meet these objectives:

- Compare and contrast a default installation and a custom installation.
- Install Windows XP Professional using a custom installation.
- Create, view, and manage disks, directories, and files.
- Identify procedures and utilities used to optimize the performance of operating systems.
- Identify procedures and utilities used to optimize the performance of browsers.
- Describe the installation, use, and configuration of e-mail software.
- Set screen resolution and update the video driver.
- Describe the installation of a second operating system.

Compare and Contrast a Default Installation and a Custom Installation

The default installation of Windows XP Professional is sufficient for most computers used in a home or small office network. A custom installation of Windows XP Professional is typically used in a larger network.

Default installation requires minimal user interaction. You are prompted to provide information for the specific computer and the owner/user.

In Windows XP, the ***custom installation*** is similar to the default installation. There are only two screens that offer a custom selection during setup. The first screen allows you to customize the regional settings, and the second screen (shown in Figure 12-2) allows you to customize the network settings.

Figure 12-2 Windows Installations Types



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A technician or a user with technical experience often performs the custom installation. In a custom installation, the wizard prompts the user for detailed performance information to ensure that the operating system is customized to meet the preferences or requirements of the individual user or the network administrator of a company. You can perform a custom Windows XP Professional installation on more than one computer on a network by using an answer file that contains predefined settings and answers to the questions that are asked by the wizard during setup.

The technician can automate and customize a Windows XP Professional installation to include the following features:

- Productivity applications, such as Microsoft Office
- Custom applications
- Support for multiple languages
- OS Deployment Feature Pack using Microsoft Systems Management Server (SMS)
- Hardware device drivers

Install Windows XP Professional Using a Custom Installation

A custom installation of Windows XP Professional can save time and provide a consistent configuration of the operating system across computers on a large network.

The most common types of custom installations are as follows:

- ***Unattended installation*** from a network distribution point using an answer file.
- ***Image-based installation*** using Sysprep and a disk-imaging program, which copies an image of the operating system directly to the hard drive with no user intervention.
- ***Remote installation*** using Remote Installation Services (RIS), which can download the installation across the network. This install can be requested by the user or forced onto the computer by the administrator.
- OS Deployment Feature Pack using Microsoft Systems Management Server (SMS), which can dramatically simplify deployment of an operating system across the organization.

The sections that follow describe these different custom installation methods in more detail.

Unattended Installation

The unattended installation using an unattend.txt answer file is the easiest custom installation method to perform on a network. An answer file can be created using an application

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called setupmgr.exe, which is located within the deploy.cab file on the Windows XP Professional CD.

Figure 12-3 shows an example of an answer file.

Figure 12-3 Sample Answer File



After you have answered all the questions, the unattend.txt file is copied to the distribution shared folder on a server. At this point, you can do one of two things:

- Run the unattended.bat file on the client machine. This prepares the hard drive and automatically installs the operating system from the server over the network.
- Create a boot disk that boots up the computer and connects to the distribution share on the server. Run the batch file to install the operating system over the network.

Image-Based Installation

When performing image-based installations, you should begin by completely configuring one computer to an operational state. Next, run Sysprep to prepare the system for imaging. A third-party drive-imaging application prepares an image of the completed computer that can be burned onto a CD or DVD. This image can then be copied onto computers with compatible hardware abstraction layers (HAL) to complete the installation of multiple computers. After the image has been copied, you can boot up the computer, but you might have to configure some settings, such as computer name and domain membership.

Remote Installation

With Remote Installation Service (RIS), the process is very much like an image-based installation, except you would not use a drive-imaging utility. You can use RIS to remotely

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set up new Microsoft Windows computers by using an RIS network shared folder as the source of the Windows operating system files. You can install operating systems on remote boot-enabled client computers. User computers that are connected to the network can be started by using a Pre-Boot eXecution Environment (PXE)–capable network adapter or remote boot disk. The client then logs on with valid user account credentials.

RIS is designed to be used in a relatively small network and should not be used over low-speed links of a wide-area network (WAN). Microsoft System Management Server (SMS) allows a network administrator to manage large numbers of computers on a network. SMS can be used to manage updates, provide remote control, and perform inventory management. An optional feature is operating system deployment, which requires the installation of the SMS OS Deployment Feature Pack on the Windows 2003 server. SMS allows the installation of a large number of client computers across the entire network, such as a LAN or WAN.



Lab 12.2.2: Advanced Installation of Windows XP

In this lab, you will install a Windows XP Professional operating system by using an answer file for automation. You will customize partition settings and create an administrative user and limited users. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Create, View, and Manage Disks, Directories, and Files

Within the operating system, disks and directories are locations where data is stored and organized. The file system used by the operating system determines additional factors that affect storage such as partition size, cluster size, and security features.

Disk Structure

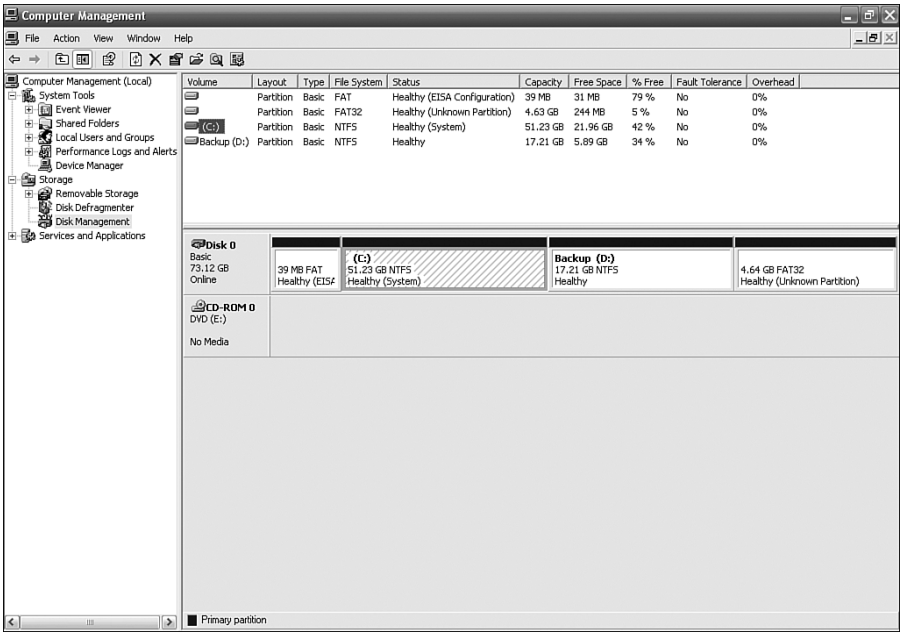
The ***Disk Management*** utility displays information and performs services such as partitioning and formatting disks in Windows. Figure 12-4 shows the Disk Management utility used in Windows XP.

You can access the Disk Management utility in the following ways:

- From the **Start** menu, right-click **My Computer** and then choose **Manage** > **Disk Management**.
- From the **Start** menu, choose **Settings** > **Control Panel** > **Administrative Tools** > **Computer Management**. Double-click **Storage**, and then double-click **Disk Management.**

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Figure 12-4 Disk Management



There are several types of partitions on a hard drive:

- Primary partitions
- Extended partitions
- Logical drives

Note

At any given time, you can only designate one partition as the active partition. The operating system uses the active partition to boot up the system. The active partition must be a primary partition.

In most cases, the C: drive is the active partition and contains the boot and system files. Some users create additional partitions to organize files or to be able to dual-boot the computer.

File System

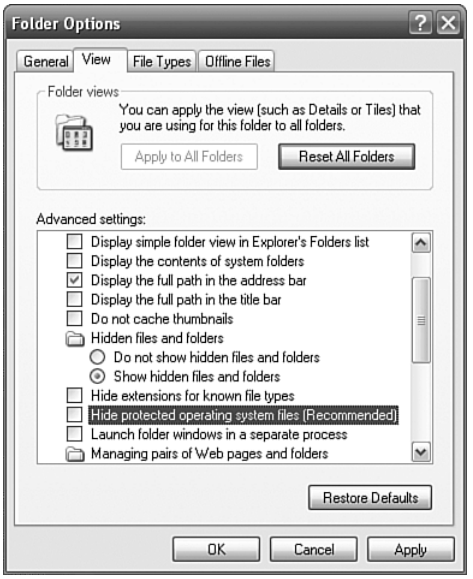
Partitions are formatted with a file system. The two file systems available in Windows XP are FAT32 and NTFS. NTFS has greater stability and security features.

For example, Windows does not display the file extension, but this practice can cause security problems. Virus writers are able to distribute executable files disguised as nonexecutable files. To avoid this security breach, you should always show file extensions. To do

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so, choose **Start** > **Control Panel** > **Folder Options** > **View** and deselect the **Hide extensions for known file types** check box, as shown in Figure 12-5.

Figure 12-5 Showing File Extensions



Note

Saving files to the root directory of the C: drive can cause organizational problems with data. It is a best practice to store data in folders created on the C: drive.

Lab 12.2.3: Additional Partitions

In this lab, you will create a FAT32-formatted partition on a disk. You will convert the partition to NTFS. You will identify the differences between the FAT32 format and the NTFS format. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Identify Procedures and Utilities Used to Optimize the Performance of Operating Systems

There are several procedures and tools available to optimize the performance of an operating system. The concepts can be the same across operating systems, but the optimization methods and procedures are different. For example, while virtual memory performs the

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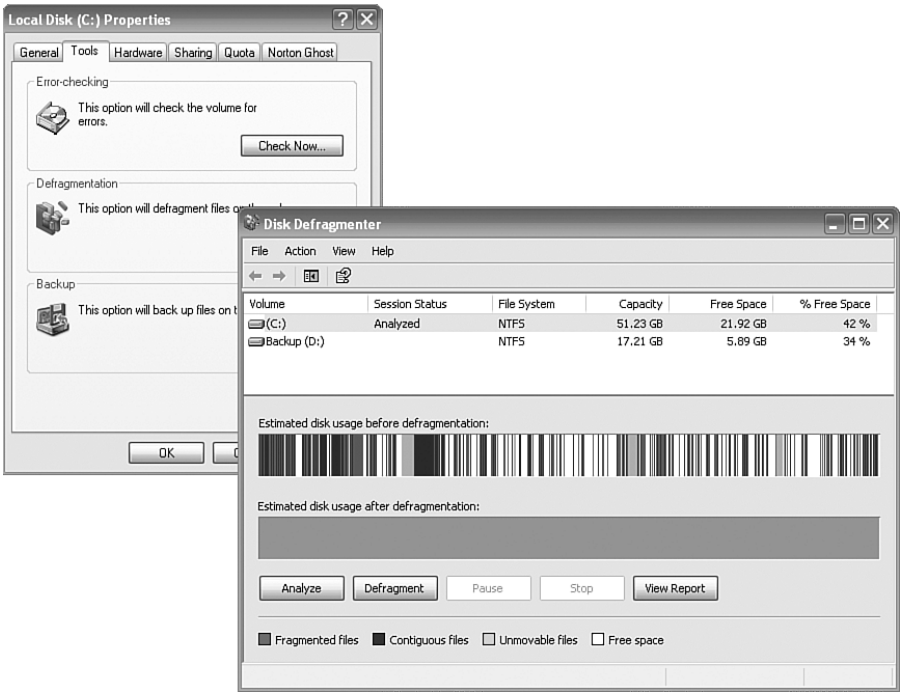
same function in the Windows 98 and Windows XP operating systems, the path to find and set virtual memory settings is different.

System Tools

To maintain and optimize an operating system, you can access various tools within Windows. Some of these tools include disk error checking, which can scan the hard drive for file structure errors, and hard drive defragmentation, which can consolidate files for faster access.

To access the hard drive management tools in Windows XP, in Windows Explorer, right-click **Local Disk (C:)** and select **Properties** from the resulting drop-down menu. Select the Tools tab from the Properties dialog box. Figure 12-6 shows the options on the Tools tab, with the Defragmentation tool activated.

Figure 12-6 Hard Drive Management Tools



Virtual Memory

Virtual memory allows the CPU to address more memory than is installed in the computer. This is done so that every application can address the same amount of memory. Virtual memory is a ***swap file*** or page file that is constantly read into and out of RAM. Typically, you should let Windows manage the size of the swap file. The only setting that you should

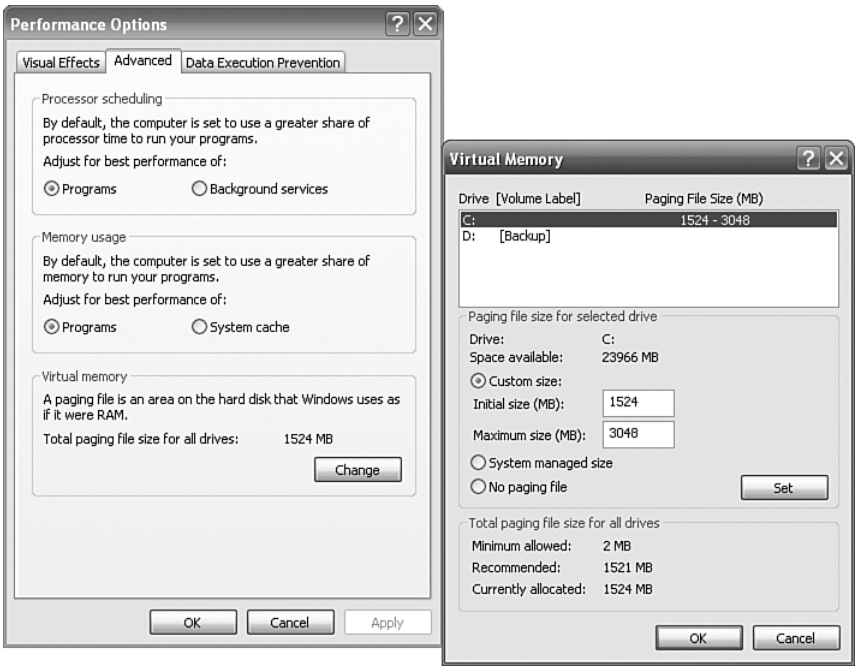
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change is the location of the swap file. You must be a member of the administrator group to make this change. To access virtual memory settings in Windows XP, use one of the following paths:

- **Start** > **Settings** > **Control Panel** > **System** > **Advanced tab** > **Performance Options**
- **Start** > **Control Panel** > **Performance and Maintenance** > **System** > **Advanced** > **Performance** > **Settings** > **Advanced**

Figure 12-7 shows virtual memory settings.

Figure 12-7 Virtual Memory



Disk Defragmenter

To help optimize the files on the hard drive, Windows operating systems provide the ***Disk Defragmenter*** utility. As files are accessed and stored on a hard drive, the files change from being contiguous on the disk to being scattered across the disk. This can cause the operating system to slow down. The hard drive has to search several areas on the hard drive platter to find the entire file. For one file, the effect of the process is minimal. When this occurs for thousands of files, however, the process will slow the reading and writing of a file to a hard drive. To defragment a drive, double-click **My Computer** on the desktop. Right-click the drive that you want to optimize, and choose **Properties**. On the Tools tab, click **Defragment Now**. Figure 12-6 showed the Disk Defragmenter interface.

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Temporary Files

Almost every program uses ***temporary files***, which are usually automatically deleted when the application or the operating system is finished using them. However, some of the temporary files must be deleted manually. Because temporary files take up hard drive space that could be used for other files, it is a good idea to check and delete them as necessary every two or three months. Temporary files are usually located in the following locations:

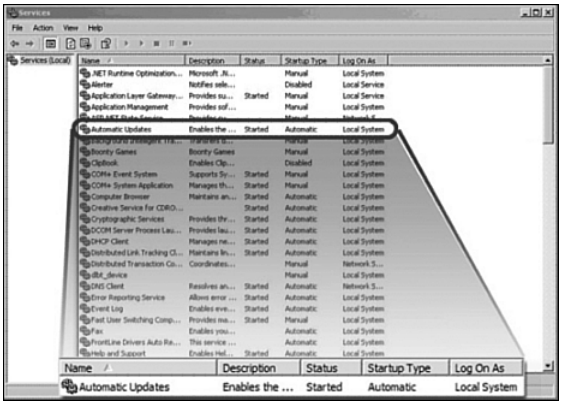
- C:\temp
- C:\tmp
- C:\windows\temp
- C:\windows\tmp
- C:\documents and settings\%USERPROFILE%\local settings\temp

Services

Services are a type of application that runs in the background to achieve a specific goal or wait for a request. Only necessary services should be started to reduce unnecessary security risks.

To access the services in Windows XP, click **Start** and then right-click **My Computer** and select **Manage**. Click the plus sign next to **Services and Applications** and then click **Services**, as shown in Figure 12-8.

Figure 12-8 Services



There are four settings, or states, that can be used to control the services:

- Automatic
- Manual

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- Disabled
- Stopped

If a service, such as DHCP or Automatic Updates, is set to Automatic, it will start up when the PC starts. Manual services, such as the support of an uninterruptible power supply (UPS), need to be manually configured to work. Some services can be stopped or disabled for troubleshooting purposes, such as turning off the print spooler when there are printer problems.



Lab 12.2.4: Customize Virtual Memory Settings

In this lab, you will customize virtual memory settings. You will customize the Startup folder and RunOnce key in the registry. You will change the default Windows Update option. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Identify Procedures and Utilities Used to Optimize the Performance of Browsers

Web browsers and e-mail applications are typically the applications used the most on a computer. Optimizing the web browsers and the e-mail application should increase the performance of the computer.

The Microsoft browser, Internet Explorer (IE), has general settings for changing the home page and browser appearance settings. Additional settings allow you to view or delete the information saved by the browser:

- History
- Temporary files
- Cookies
- Passwords
- Web-form information

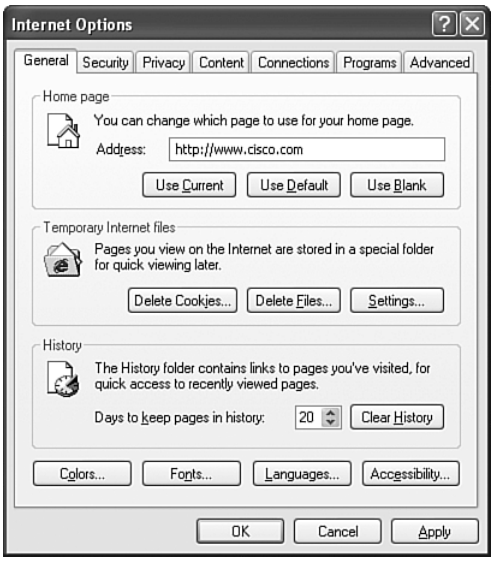
Note

Cookies hold information transmitted between a web browser and a web server with the purpose of tracking user information to customize the page delivered to the user.

To access the settings in IE, open an IE browser window and choose **Tools** > **Internet Options**, as shown in Figure 12-9. The list that follows describes the settings you can access from the tabs in this window.

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Figure 12-9 Internet Explorer Options



- **General**: Used to set the home page, view and delete temporary Internet files, and change the browser appearance settings
- **Security**: Used to select Internet zones and trusted sites
- **Privacy**: Used for privacy settings to block third-party cookies and pop-ups
- **Content**: Used to block unwanted website content and set identification and personal information
- **Connections**: Used to set up the Internet Connection settings for the browser
- **Programs**: Used to set up which programs Windows automatically uses for each Internet service
- **Advanced**: Used to enable and disable operation settings of the browser

Caching, or storing, Internet files is a feature of the web browser that is used to speed the process of accessing previously visited websites. The file-storing tool in IE downloads copies of the images or the HTML files of sites you have visited to the hard disk. When you revisit the website, the site opens more quickly because the files are in the local disk cache and do not need to be downloaded again.

Cached files in the web browser can become outdated or can be very large. These IE settings allow you to control the size of the cache and indicate when the cache should be refreshed:

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- Every visit to the page
- Every time you start IE
- Automatically
- Never

To access the cache settings, click **Settings** in the Temporary Internet files section of the Internet Options window shown previously in Figure 12-9.



Lab 12.2.5: Install an Alternate Browser (Optional)

In this lab, you will install the Mozilla Firefox web browser. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Describe Installation, Use, and Configuration of E-Mail Software

E-mail software can be installed as part of a web browser or as a standalone application. Outlook Express is an e-mail tool that is a component of the Microsoft Windows operating system. To configure Outlook Express, you must provide information about your e-mail account, as shown in Figure 12-10.

Figure 12-10 E-Mail Account Information



You should have the following information available when installing e-mail accounts into the e-mail client software:

- Display name
- E-mail address
- Type of incoming mail server, such as POP3 or IMAP

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- Incoming mail server name
- Outgoing mail server name
- Username
- Account password

The protocols used in e-mail include the following:

- **Post Office Protocol version 3 (POP3)**: Retrieves e-mails from a remote server over TCP/IP. It does not leave a copy of the e-mail on the server; however, some implementations allow users to specify that mail be saved for some period of time.
- **Internet Message Access Protocol (IMAP)**: Allows local e-mail clients to retrieve e-mail from a server. Typically leaves a copy of the e-mail on the server until you move the e-mail to a personal folder in your e-mail application. IMAP synchronizes e-mail folders between the server and client.
- **Simple Mail Transfer Protocol (SMTP)**: Transmits e-mails across a TCP/IP network. It is the e-mail format for text that only uses ASCII encoding.
- **Multipurpose Internet Mail Extensions (MIME)**: Extends the e-mail format to include text in ASCII standard, as well as other formats such as pictures and word processor documents. Normally used in conjunction with SMTP.

Additional features are available with e-mail software:

- Automatic handling rules for e-mails
- Different e-mail coding, such as HTML, plain text, or rich text
- Newsgroups

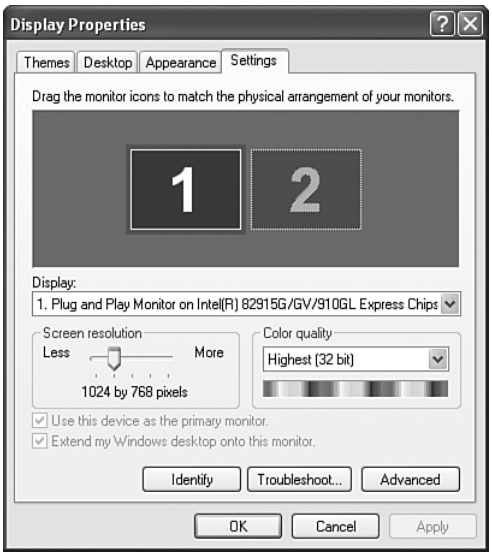
Set Screen Resolution and Update Video Driver

After the operating system is installed, you can set the screen resolution to meet the requirements of your customer. If the screen resolution is not set properly, you can get unexpected display results from different video cards and monitors. The unexpected results could include a Windows desktop that does not take up the full area of the screen or a blank screen if the resolution is set too high.

When using an LCD screen, the resolution should be set to native mode, or native resolution. Native mode is the screen resolution that is the same as the number of pixels that the monitor has. If you change from the native mode, the monitor does not produce the best picture. See Figure 12-11 for the screen resolution settings on a Windows XP Professional computer.

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Figure 12-11 Display Properties



You can change the screen settings on the Settings tab of the Display Properties control panel applet:

- **Screen resolution**: Determines the number of pixels. A higher number of pixels displays a better resolution and picture.
- **Refresh rate**: Determines how often the image on the screen is redrawn. Refresh rate is expressed in hertz (Hz). The higher the refresh rate, the more steady the screen image.
- **Display colors**: Determines the number of colors visible on the screen at once. Colors are created by varying the intensity of the three basic colors (red, green, and blue). The more bits, the greater the number of colors. The following is a list of color depths:
  - **256 colors**: 8-bit color
  - **65,536 colors**: 16-bit color (High Color)
  - **16 million colors**: 24-bit color (True Color)
  - **16 million colors**: 24-bit color (True Color with 8-bit padding to allow 32-bit processing)

When troubleshooting a display problem, check that the driver is fully compatible with the graphics card. Windows might install a default driver that works, but might not provide all the available options for best viewing and performance. See Figure 12-12 for the video driver update utility in Windows XP Professional.

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Figure 12-12 Video Driver Update



Perform the following steps for the best graphical performance:

How To

Step 1. Download the most recent driver from the manufacturer's website.

Step 2. Remove the current driver.

Step 3. Disable antivirus software.

Step 4. Install the new driver.

Step 5. Restart the computer.

Note

Disabling the antivirus software leaves your computer vulnerable to viruses and should not be done if you are connected to the Internet.

You might encounter problems when you install or reinstall a video driver. For example, after performing the graphical performance steps, you are unable to view the screen when you restart the computer. To investigate the problem and restore the settings, reboot the computer. During the boot phase, press **F8**. Enter the boot options when prompted and select **Enable VGA Mode** to use a 640 x 480 resolution. When the operating system is loaded, you can then select **Roll Back Driver** from the **Properties** menu of the graphics card. You should then do some research to determine the possible issues with the driver that you tried to install.

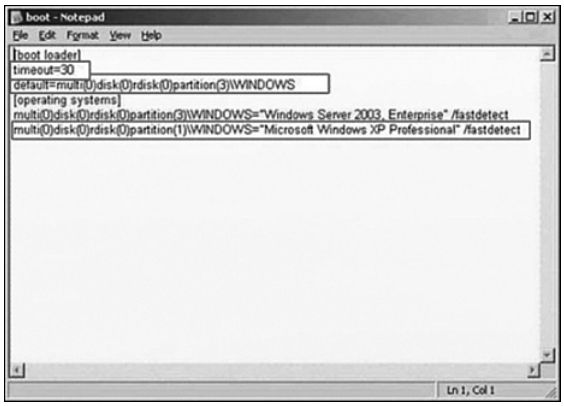
Describe Installation of a Second Operating System

You can have multiple operating systems on a single computer. Some software applications might require the most recent version of an operating system, while other applications

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require an older version. There is a dual-boot process for multiple operating systems on a computer. When the boot.ini file determines that more than one operating system is present during the boot process, you are prompted to choose the operating system that you want to load. Figure 12-13 shows a sample boot.ini file.

Figure 12-13 boot.ini File



To create a dual-boot system in Microsoft Windows, you typically must have more than one hard drive or the hard drive must contain more than one partition.

For a ***dual-boot setup***, you should install the *oldest* operating system on the primary partition or the hard drive marked as the active partition first. You should then install the second operating system on the second partition or hard drive. The boot files are automatically installed in the active partition.

During the installation, the boot.ini file is created on the active partition to allow the selection of the operating system to boot on startup. The boot.ini file can be edited to change the order of the operating systems. You can also edit the file for the length of time an operating system selection can be made during the boot phase. Typically, the default time to select an operating system is 30 seconds. This always delays the boot time of the computer by 30 seconds, unless the user intervenes to select a particular operating system. In the boot.ini file, the boot time should be changed to 5 or 10 seconds to boot up the computer faster.

To edit the boot.ini file, right-click My Computer and choose Properties > Advanced tab. In the Startup and Recovery area, select Settings and then click Edit.

Describe How to Upgrade Operating Systems

An operating system must be upgraded periodically to remain compatible with the latest hardware and software. When newer versions of an operating system are released, support for older operating systems is eventually withdrawn.

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Hardware products are continually coming on the market. The new design of the products often requires that the latest operating system be installed to operate correctly. While this might be expensive, you gain advanced functionality through new features and support for newer hardware.

A Windows XP upgrade can be performed from a CD or over a network. You should ensure that the new operating system is compatible with the computer. Microsoft provides a utility called the Upgrade Advisor, as shown in Figure 12-14, to scan the system for incompatibility issues before upgrading to newer Windows operating systems. You can download the Upgrade Advisor from the Microsoft Windows website free of charge. After the Upgrade Advisor is finished, a report is produced to inform you of any problems. Incompatibility in hardware is the most common reason for failure in the upgrade process.

Figure 12-14 Windows Upgrade Advisor



Not all older Windows operating systems are upgradeable to the newer versions, as described in the following list:

- Windows 98, Windows 98 SE, and Windows Me can be upgraded to Windows XP Home or Windows XP Professional.
- Windows NT workstation 4.0 with Service Pack 6 and Windows 2000 Professional can be upgraded only to Windows XP Professional.
- Windows 3.1 and Windows 95 cannot be upgraded to Windows XP.

Note

Remember to back up all data prior to beginning the upgrade.

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Describe Preventive Maintenance Procedures for Operating Systems

Preventive maintenance for an operating system includes automating tasks to perform scheduled updates. It also includes installing service packs that help keep the system up to date and compatible with new software and hardware.

If a driver or system becomes corrupted, you can use ***restore points*** to restore the system to a previous state. However, restore points cannot recover lost data.

After completing the following sections, you will meet these objectives:

- Schedule automatic tasks and updates
- Set restore points

Schedule Automatic Tasks and Updates

You can automate tasks in Windows XP using the Scheduled Tasks utility. The Scheduled Tasks utility monitors selected, user-defined criteria and then executes the tasks when the criteria have been met.

GUI Scheduled Tasks

Some of the common tasks that are automated using the Scheduled Tasks utility include the following:

- Disk cleanup
- Backup
- Disk defragmenter
- Starting other applications

To open the Scheduled Tasks wizard, choose **Start** > **All Programs** > **Accessories** > **System Tools** > **Scheduled Tasks**. Double-click **Add Scheduled Task**, as shown in Figure 12-15.

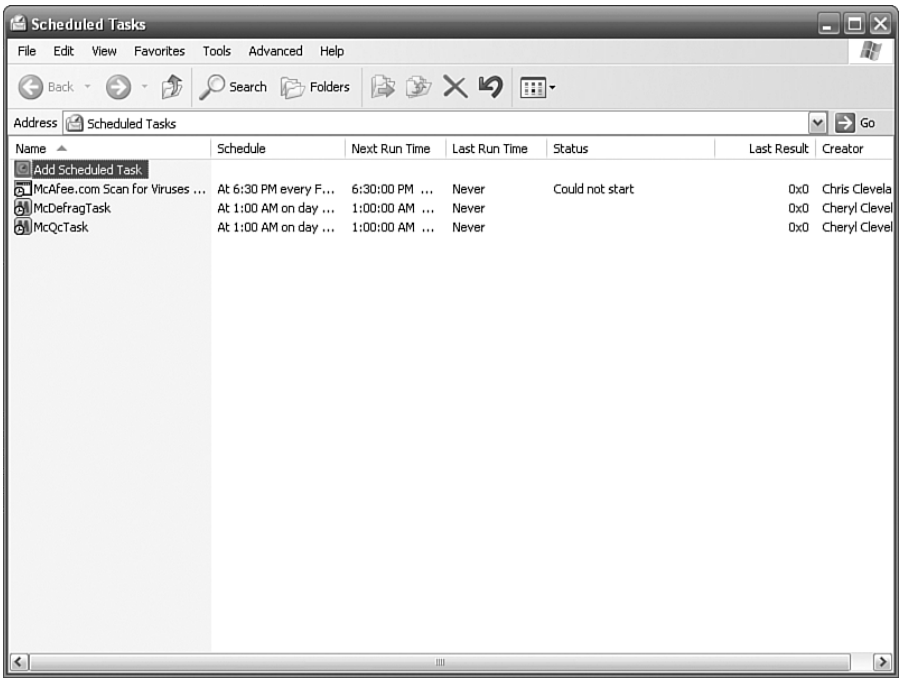
CLI Scheduled Tasks

The Scheduled Tasks utility is a Windows-based GUI utility. You can also use the **at** command in the command-line utility to automatically schedule a command, a script file, or an application to run at a specific date and time. To use the **at** command, you must be logged in as a member of the administrator group.

To learn more about the **at** command, choose **Start** > **Run**. At the CLI prompt, type **cmd** and then press **Enter**. At the command prompt, type **at/?**.

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Figure 12-15 Scheduling Automated Tasks



Windows Automatic Updates

You should use one of the following methods to configure updates for the Windows XP operating system:

- Automatic (need to specify a date and time)
- Download updates for me, but let me choose when to install them
- Notify me but don't automatically download or install them
- Turn off Automatic Updates

You can access the Automatic Updates screen, shown in Figure 12-16, from the Control Panel.

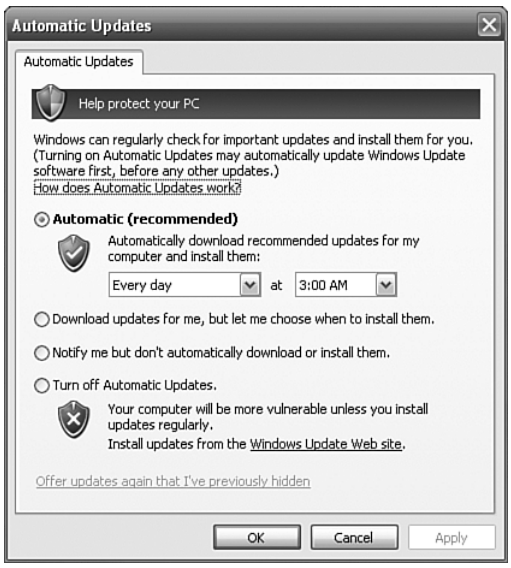


Lab 12.4.1: Schedule Task Using GUI and the at Command

In this lab, you will schedule a task using the Windows XP GUI and schedule a task in a command window using the **at** command. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

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Figure 12-16 Automatic Updates



Set Restore Points

Restore points return the operating system to a predefined point in time. In some cases, the installation of an application or a hardware driver can cause instability or create unexpected changes to the computer. Uninstalling the application or hardware driver normally corrects the problem. If uninstalling does not solve the problem, you should try to restore the computer to an earlier time when the system worked properly.

To open the System Restore utility, as shown in Figure 12-17, choose **Start** > **All Programs** > **Accessories** > **System Tools** > **System Restore**.

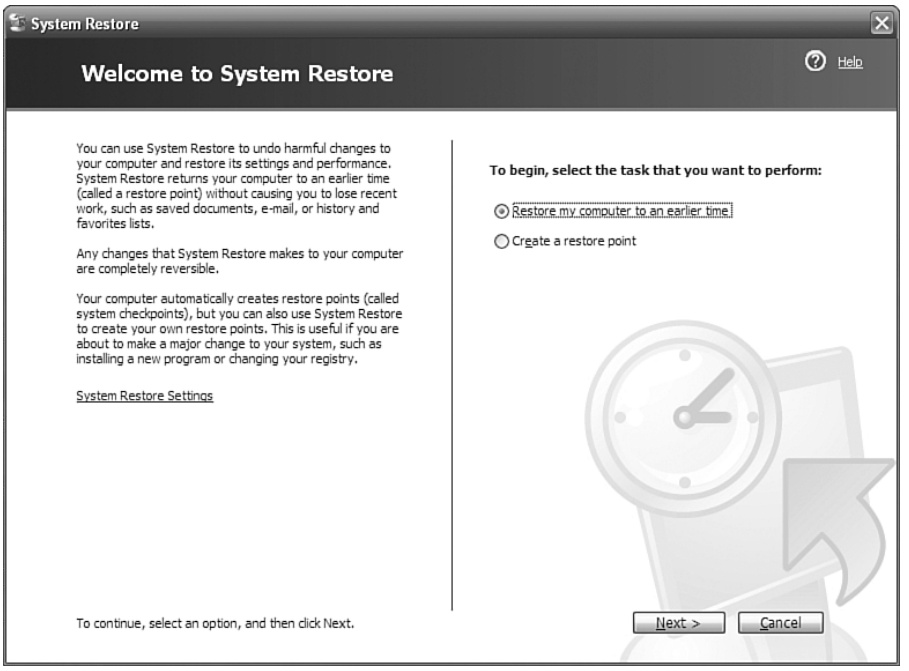
Windows XP can create restore points in the following scenarios:

- When an install or upgrade takes place
- Every 24 hours, if the computer is running
- Manually, at any time

The restore points contain information about the system and registry settings that are used by Windows operating systems. System Restore does not back up personal data files nor recover personal files that have been corrupted or deleted. To back up data, you should use a dedicated backup system, such as a tape drive, CDs, or even a USB storage device.

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Figure 12-17 System Restore



Troubleshoot Operating Systems

The troubleshooting process helps resolve problems with the operating system. These problems range from simple, such as a driver that does not operate properly, to complex, such as a system that locks up. Use the following troubleshooting steps as a guideline to help you diagnose and repair problems:

How To

Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

After completing the following sections, you will meet these objectives:

- Review the troubleshooting process
- Identify common problems and solutions
- Apply troubleshooting skills

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Review the Troubleshooting Process

Computer technicians must be able to analyze the problem and determine the cause of the error to repair the computer. This process is called *troubleshooting*.

Step 1: Gather Data from the Customer

The first step in the troubleshooting process is to gather data from the customer. Table 12-3 provides a list of open-ended and closed-ended questions to ask the customer about operating system errors. (This list is *not* comprehensive.)

Table 12-3 OS Errors: Open-Ended and Close-Ended Questions to Ask

Open-Ended Questions	Closed-Ended Questions
Have you made any changes to your system?	Can you access the Internet?
Have you been on the Internet?	Does anyone else have this problem?
Has anyone else had access to your computer?	Have you changed your password recently?
Does the system look different?	Have you received any error messages on your computer?

Step 2: Verify the Obvious Issues

After you have talked to the customer, you should verify the obvious issues that apply to the operating system:

- Do you have the current service pack installed?
- Do you have the current drivers installed?
- Do you run a virus spyware scanner?
- Have you changed any system defaults?
- Have you noticed problems with the screen resolution?
- Have you noticed problems when running certain applications?
- Has any software been added or upgraded?
- Has any hardware been added or removed?
- Have any cables been added or disconnected?

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Step 3: Try Quick Solutions First

After the obvious issues have been verified, try some quick solutions to operating system problems:

- Reboot the computer (warm boot)
- Turn the computer off and then on (cold boot)
- Driver roll back
- System restore
- Last known good configuration
- Virus scan
- Spyware scan

Step 4: Gather Data from the Computer

If quick solutions did not correct the problem, it is time to gather data from the computer, including information about or from the following:

- System files
- Event logs
- Device Manager
- Configuration files
- Restore points
- Diagnostic software

Step 5: Evaluate the Problem and Implement the Solution

At this point, you will have enough information to evaluate the problem and research and implement possible solutions. Some examples of resources for possible solutions include

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals

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- Online forums
- Technical websites

Step 6: Close with the Customer

After you have solved the problem, you will close with the customer, which requires completing the following tasks:

How To

Step 1. Discuss the solution implemented with customer.

Step 2. Have the customer verify that the problem has been solved.

Step 3. Provide the customer with all paperwork.

Step 4. Document the steps taken to solve the problem in the work order and the technician's journal.

Step 5. Document any components used in the repair.

Step 6. Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Computer problems can be attributed to hardware, software, networks, or some combination of the three. You will resolve some types of computer problems more often than others. A stop error is a hardware or software malfunction that causes the system to lock up. This type of error is known as the blue screen of death (BSoD) and appears when the system is unable to recover from an error. The BSoD is usually caused by device driver errors. The Event Log and other diagnostic utilities are available to research a stop error or BSoD error. To prevent these types of errors, verify that the hardware and software drivers are compatible. In addition, install the latest patches and updates for Windows. When the system locks up during startup, the computer can automatically reboot. The reboot is caused by the auto-restart function in Windows and makes it difficult to see the error message. The auto-restart function can be disabled in the Advanced Startup Options menu. Table 12-4 is a chart of common operating system problems and solutions.

Table 12-4 Common Operating System Problems and Solutions

Problem Symptom	Possible Solution
You have a dual-boot system, but you are unable to access the second operating system.	Make sure the boot.ini is not corrupt and verify that it is correct.
A screen goes blank after you install an updated graphics driver.	If the new driver is bad, boot to VGA mode and use Roll Back Driver to restore the previous driver.

continues

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Table 12-4 Common Operating System Problems and Solutions *continued*

Problem Symptom	Possible Solution
A customer plans to install Windows XP on 100 computers in a branch office over a weekend, but is very concerned about how much time it will take.	Advise the customer that the installation CD will take too long. Consult with customer about one of the automated installation solutions.
The customer is receiving warnings about the hard drive becoming too full.	Run the Disk Cleanup utility to delete temporary files.
A customer receives error messages that an application will not launch because a required service is not running.	Ask the customer for the name of the service in the error message and restart the service.



Lab 12.5.3: Fix an Operating System Problem

In this lab, you troubleshoot and fix a computer that does not connect to the network. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.



Remote Technician Activity 12.5.3: Fix an Operating System Problem

In this Remote Technician Activity, you will gather data from the customer and then instruct the customer on how to fix a computer that does not connect to the network. You will then document the customer's problem in the work order provided in the activity. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this activity now or wait until the end of the chapter.

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Summary

This chapter discussed how to select an operating system based on the needs of the customer. You have learned the differences between operating systems and network operating systems. The labs have helped you become familiar with using Windows XP, creating partitions, customizing virtual memory, and scheduling tasks. You have also learned some optimization tips for operating systems, as well as how to troubleshoot a computer problem from the perspective of a level-two technician. The following concepts discussed in this chapter will be useful to you when selecting and installing an operating system:

- Ensure that you fully understand the technology needs of the customer.
- Know the differences between common operating systems.
- Carefully match the customer needs to the proper technologies.
- Know the different methods to install an operating system.
- Know how to upgrade different operating systems.
- Understand how preventive maintenance can stop problems before they start.
- Know which preventive maintenance procedures are appropriate for the customer.
- Know how to troubleshoot operating system problems.

Summary of Exercises

This is a summary of the Labs, Worksheets, Remote Technician exercises, Class Discussions, Virtual Desktop activities, and Virtual Laptop activities associated with this chapter.



Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6):

Lab 12.2.2: Advanced Installation of Windows XP

Lab 12.2.3: Additional Partitions

Lab 12.2.4: Customize Virtual Memory Settings

Lab 12.2.5: Install an Alternate Browser (Optional)

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Lab 12.4.1: Schedule Task Using GUI and the at Command

Lab 12.5.3: Fix an Operating System Problem



Remote Technician Activity

The following activity covers material from this chapter. Refer to the full text in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6):

Remote Technician Activity 12.5.3: Fix an Operating System Problem

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. How many active partitions can a hard drive have?

   a. 1
   b. 2
   c. 3
   d. 4

2. Which of the following file systems can be used by Windows XP? (Choose two.)

   a. DOS
   b. EXT3
   c. FAT32
   d. HPFS
   e. NTFS
   f. Vista

3. Which system tool consolidates files to enable faster access?

   a. File attributes
   b. Computer management
   c. Defragmentation
   d. Disk format

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4. How can the Last Known Good Configuration option be accessed?

   a. Press **F8** to access the advanced boot options.
   b. Choose **Start** > **All Programs** > **System Tools** > **Restore**.
   c. Choose **Start** > **All Programs** > **Accessories** > **System Tools** > **Backup**.
   d. Press **Delete** to access the Recovery Console.

5. A new graphics card is installed in a computer. When the computer is powered on, the default drivers are loaded but some of the applications do not work properly. What should the user do to improve the graphics card performance?

   a. Check the Microsoft website to find the latest drivers.
   b. Check the website of the manufacturer for the latest drivers.
   c. Configure the application to run correctly with the new graphics card.
   d. Configure the graphics card settings correctly in the Start menu.

6. Which is the default Windows Update setting?

   a. Automatically download recommended updates for my computer and install them.
   b. Download updates for me, but let me choose when to install them.
   c. Notify me but don't automatically download or install them.
   d. Turn off Automatic Updates.

7. Which Windows XP function allows a system to roll back to a previous state?

   a. Automatic Update
   b. ntbackup
   c. Restore point
   d. scanreg

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CHAPTER 13

Advanced Laptops and Portable Devices

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- What are wireless communication methods for laptops and portable devices?
- How can I repair laptops and portable devices?
- What is the best way to select laptop components?
- What are the preventive maintenance procedures for laptops?
- How do I troubleshoot a laptop?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

laptop *page xx*

portable device *page xx*

docking station *page xx*

Bluetooth *page xx*

hands-free headset *page xx*

infrared (IR) wireless technology *page xx*

cellular WAN *page xx*

Wireless Fidelity (Wi-Fi) *page xx*

IEEE standard *page xx*

WPA *page xx*

WPA2 *page xx*

satellite technology *page xx*

Customer-Replaceable Unit (CRU) *page xx*

Field-Replaceable Unit (FRU) *page xx*

original equipment manufacturer (OEM) *page xx*

S-Video *page xx*

external USB hard drive *page xx*

Firewire hard drive *page xx*

DVD/CD burner *page xx*

Small-Outline DIMM (SODIMM) *page xx*

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With the increase in demand for mobility, the popularity of ***laptops*** and ***portable devices*** will continue to grow. During the course of your career, you will be expected to know how to configure, repair, and maintain these devices. The knowledge you acquire about desktop computers will help you service laptops and portable devices. However, there are important differences between the two technologies.

To facilitate mobility, laptops and portable devices use wireless technologies more than desktops. All laptops use batteries when they are disconnected from a power source. ***Docking stations*** are commonly used to connect a laptop to peripheral devices. As a computer technician, you will be required to configure, optimize, and troubleshoot these docking stations and accessories, as well as the laptop or portable device that they accompany. Many laptop components are proprietary, so some manufacturers require that you complete specialized certification training to perform laptop repairs.

Servicing laptops can be very challenging. Mastering the skills necessary to work on laptops is important to your career advancement.

Describe Wireless Communication Methods for Laptops and Portable Devices

Wireless devices give people the freedom to work, learn, play, and communicate wherever they want. People using wireless-capable devices do not need to be tied to a physical location to send and receive voice, video, and data communications. As a result, wireless facilities, such as Internet cafes, are opening in many countries. College campuses use wireless networks to allow students to sign up for classes, watch lectures, and submit assignments in areas where physical connections to the network are unavailable. This trend toward wireless communications will continue to grow as more people use wireless devices.

After completing this section, you will meet these objectives:

- Describe Bluetooth technology.
- Describe infrared technology.
- Describe cellular WAN technology.
- Describe Wi-Fi technology.
- Describe satellite technology.

Describe Bluetooth Technology

Bluetooth is a wireless technology that enables devices to communicate over short distances. A Bluetooth device can connect up to seven other Bluetooth devices to create a wireless personal-area network (WPAN). This technical specification is described by the

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Institute of Electrical and Electronics Engineers (IEEE) 802.15.1 standard. Bluetooth devices can handle voice and data and are ideally suited for connecting the following devices:

- Laptops
- Printers
- Cameras
- PDAs
- Cell phones
- ***Hands-free headsets***

Common Bluetooth characteristics include the following:

- Bluetooth is a short-range wireless technology designed to eliminate the need for cables between portable and fixed-configuration devices.
- It operates at 2.4 to 2.485 GHz in the unlicensed Industrial, Scientific, and Medical (ISM) band.
- It uses little power and has a low cost and a small size.
- It uses adaptive frequency hopping (AFH).

The distance of a Bluetooth personal-area network (PAN) is limited by the amount of power used by the devices in the PAN. Bluetooth devices are broken into three classifications, as shown in Table 13-1. The most common Bluetooth network is Class 2, which has a range of approximately 33 feet (10 m).

Table 13-1 Bluetooth Classifications

Class	Maximum Permitted Power (in mW)	Approximate Distance
Class 1	100 mW	~330 feet (100 m)
Class 2	2.5 mW	~33 feet (10 m)
Class 3	1 mW	~3 feet (1 m)

Bluetooth devices operate in the 2.4- to 2.485-GHz radio frequency range, which is in the ISM band. This band often does not require a license if approved equipment is used. The Bluetooth standard incorporates AFH. AFH allows signals to “hop around” using different frequencies within the Bluetooth range, thereby reducing the chance of interference when multiple Bluetooth devices are present. AFH also allows the device to learn frequencies that are already in use and to choose a different subset of frequencies.

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Security measures are included in the Bluetooth standard. The first time that a Bluetooth device connects, the device is authenticated using a personal identification number (PIN). Bluetooth supports both 128-bit encryption and PIN authentication.

Describe Infrared Technology

Infrared (IR) wireless technology is a low-power, short-range wireless technology. IR transmits data using Light-Emitting Diodes (LED) and receives data using photodiodes.

IR wireless networks are globally unregulated. However, the Infrared Data Association (IrDA) defines the specifications for IR wireless communication. Common IR characteristics include the following:

- IR wireless technology is low-power, short-range, wireless technology that uses LEDs.
- Infrared light signals operate in the lowest light frequency, and transmission distances are limited to a few feet or meters.
- Infrared light cannot penetrate ceilings or walls.

Four types of IR networks exist:

- **Line of sight:** The signal is transmitted only if there is a clear, unobstructed view between devices.
- **Scatter:** The signal bounces off ceilings and walls.
- **Reflective:** The signal is sent to an optical transceiver and is redirected to the receiving device.
- **Broadband optical telepoint:** Transmission can handle high-quality multimedia requirements.

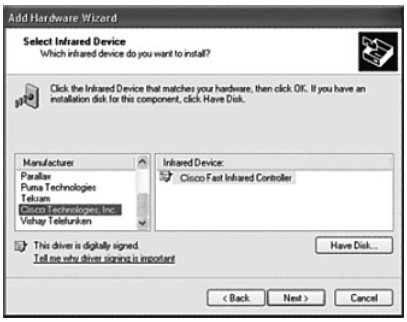
Infrared networks are ideal for connecting laptops to the following types of devices that are in close proximity:

- Multimedia projector
- PDA
- Printer
- Remote control
- Wireless mouse
- Wireless keyboard

Setting up and configuring IR devices is quite simple. Many IR devices connect to the USB port on a laptop or desktop computer. As soon as the computer detects the new device, Windows XP installs the appropriate drivers, as shown in Figure 13-1.

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Figure 13-1 Installing an Infrared Driver



The installation is similar to setting up a LAN connection.

IR is a practical, short-range connection solution, but it has some limitations:

- IR light cannot penetrate ceilings or walls.
- IR signals are susceptible to interference and dilution by strong light sources, such as florescent lighting.
- Scatter IR devices can connect without line of sight, but data transfer rates are lower, and distances are shorter.
- IR distances should be 3 feet (1 m) or less when used for computer communications.

Describe Cellular WAN Technology

Originally, cellular networks were designed for voice communication only. Cellular technology has been evolving and now enables the transfer of voice, video, and data simultaneously. It also enables the use of laptops and portable devices remotely. With a ***cellular WAN*** adapter installed, a laptop user can travel and access the Internet. Common cellular WAN characteristics include the following:

- Cellular WAN connections are powerful two-way wireless networks that have been around since the late 1970s.
- Cellular networks operate in one of two ranges: approximately 800 MHz and approximately 1900 MHz.
- Three generations of cellular WAN include voice-only analog, digital, and high-speed data and voice.

Although they are slower than DSL and cable connections, cellular WANs are still fast enough to be classified as a high-speed connection. To connect a laptop to a cellular WAN,

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you should install an adapter that is designed to work with cellular networks. A cellular adapter needs to support some or all of the following:

- **Global System for Mobile Communications (GSM):** Worldwide cellular network.
- **General Packet Radio Service (GPRS):** Data service for users of GSM.
- **Quad-band:** Allows a cellular phone to operate on all four GSM frequencies: 850 MHz, 900 MHz, 1800 MHz, and 1900 MHz.
- **Short Message Service (SMS):** Text messages.
- **Multimedia Messaging Service (MMS):** Multimedia messages.
- **Enhanced Data Rates for GSM Evolution (EDGE):** Provides increased data rates and improved data reliability.
- **Evolution Data Optimized (EV-DO):** Faster download rates.

Connecting to a cellular WAN is a simple process. Cellular WAN cards, as shown in Figure 13-2, are "plug and play." These cards plug in to the PC Card slot or are built in to the laptop.

Figure 13-2 Cellular WAN Card



Describe Wi-Fi Technology

The wireless technology ***Wireless Fidelity (Wi-Fi)*** is based on IEEE 802.11 networking standards and specifications. The number 802.11 denotes a set of standards that are specified in the IEEE 802.11 documentation. Hence, the terms 802.11 and Wi-Fi are interchangeable. Here are some characteristics of Wi-Fi:

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- Wi-Fi is a wireless technology that provides a simple connection from anywhere within range of a base station.
- Connection distances are 300 feet (91 m) or more, depending on the environment.
- Ease of access makes Wi-Fi a simple solution for network connectivity.

Currently, four major Wi-Fi 802.11 standards exist:

- 802.11a
- 802.11b
- 802.11g
- 802.11n (draft standard)

Technicians often refer to Wi-Fi standards by just the final letter. For example, a technician may refer to an 802.11b wireless router as simply a "b" router.

The 802.11g standard was released in 2003 and currently is the most common Wi-Fi standard. The 802.11n standard was released in draft form in 2006 and may be modified slightly before becoming an official ***IEEE standard***.

The 802.11b, 802.11g, and 802.11n standards use the 2.4-GHz frequency band. The 2.4-GHz frequency band is unregulated and heavily used. The large amount of traffic can cause wireless signals in the 2.4-GHz range to be interfered with by other 2.4-GHz wireless devices, such as cordless phones. For this reason, the 802.11a standard was designed to use the 5.0-GHz frequency band. As a result, 802.11a is incompatible with other 802.11*x* standards. Table 13-2 provides data rate and range information for the four major Wi-Fi standards.

Table 13-2 Wi-Fi Standards

Standard	Release Date	Maximum Data Rate	Range
802.11a	1999	54 Mbps	~100 feet (30.5 m)
802.11b	1999	11 Mbps	~100 feet (30.5 m)
802.11g	2003	54 Mbps	~100 feet (30.5 m)
802.11n	2006 (draft)	540 Mbps	~165 feet (50.3 m)

Security is a major concern for wireless networks. Anyone within the coverage area of a wireless router can potentially gain access to the network. The following precautions should be taken for security purposes:

- Never send login or password information using clear, unencrypted text.
- Use a VPN connection when possible.

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- Enable security on home networks.
- Use Wi-Fi Protected Access (***WPA***) security.

Wi-Fi Protected Access standards (WPA, ***WPA2***) are used to secure Wi-Fi networks. WPA uses a sophisticated encryption and authentication technology to protect data flow between Wi-Fi devices. WPA uses a 128-bit encryption key and should be enabled on all wireless devices. WPA was introduced to replace wired equivalent privacy (WEP), which had known security issues.

Describe Satellite Technology

Satellite technology service is ideal for rural or remote users who require high-speed broadband access in areas where no other high-speed services are available. However, because of the higher initial cost and relatively slower speeds, high-speed satellite network connections are recommended only if a cable or Digital Subscriber Line (DSL) connection is unavailable. Common satellite characteristics include the following:

- Satellite networks are faster than dialup connections but are slower than cable and DSL connections.
- Satellite service is ideal for the rural or remote Internet users.
- Downloading files is faster than uploading files.
- Adverse weather conditions can interfere with satellite reception.

Satellite Internet connections use two-way data channels. One channel is used for uploading and another for downloading. Both download and upload can be accomplished using a satellite connection. In some cases, a telephone line and modem are used for the upload. Download speeds typically are in the 500-kbps range, and uploads are about 50 kbps, making this an asymmetrical connection similar to DSL. Satellite connections are slower than cable or DSL connections but are faster than telephone modem connections. Some advantages of connecting by satellite are as follows:

- Two-way, high-speed Internet access, available in rural and remote areas
- Quick file downloads
- Satellite dish may also be used for TV access

Proper placement, installation, and configuration of a satellite system are important for the system to work effectively. Even if you point the satellite dish toward the equator, where most satellites orbit the Earth, obstructions and adverse weather can still interfere with signal reception.

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Specific equipment is needed to set up a satellite connection:

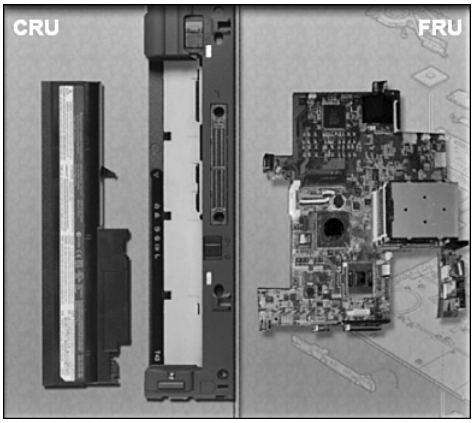
- 24-inch (610-mm) satellite dish
- Modem for uplink and downlink
- Coaxial cable and connectors

Describe Repairs for Laptops and Portable Devices

When a laptop or portable device begins to malfunction, what should you do? The customer can replace some parts of a laptop, typically called ***Customer-Replaceable Units (CRU)***. CRUs include such components as the laptop battery and additional RAM. Parts that the customer should not replace are called ***Field-Replaceable Units (FRU)***. FRUs include such components as the laptop motherboard, LCD display, and keyboard. In many cases, the device may need to be returned to the place of purchase, a certified service center, or even the manufacturer.

Figure 13-3 shows an example of a CRU and FRU.

Figure 13-3 Repair Methods for Laptops and Portable Devices



A repair center can provide service on laptops made by different manufacturers, or a repair center may specialize in a specific brand and be considered an authorized dealer for warranty work and repair. The following are common repairs performed at local repair centers:

- Hardware and software diagnostics
- Data transfer and recovery
- Hard drive installation and upgrades

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- RAM installation and upgrades
- Keyboard and fan replacement
- Internal laptop cleaning
- LCD screen repair
- LCD inverter and backlight repair

Most repairs to LCD displays must be performed in a repair center. These repairs include replacing the LCD screen, the backlight that shines through the screen to illuminate the display, and the inverter that produces the high voltage required by the backlight. If the backlight has failed, the screen is visible only when you look at it from an angle.

If no local services are available, you might be required to send the laptop to a regional repair center or to the manufacturer. If the laptop damage is severe or requires specialized software and tools, the manufacturer can decide to replace the laptop instead of attempting a repair.

Caution

Before attempting to repair a laptop or portable device, check the warranty to see if repairs during the warranty period must be done at an authorized service center to avoid invalidating the warranty. If you repair a laptop yourself, you should always back up the data and disconnect the device from the power source.



Worksheet 13.2.0: Investigating Repair Centers

For this worksheet, you investigate the services provided by a computer repair center. Use the Internet or a local phone directory to locate one. After you have found a repair center, use its website to obtain information, and answer the questions in the worksheet. If a website is not available, contact the local repair center. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

Select Laptop Components

Laptop components need to be replaced for a variety of reasons:

- The original part might be worn, damaged, or faulty.
- You might want additional functionality, such as a wireless PC card that supports new standards.
- You might want to improve performance by adding memory.

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When implementing any of these changes, make sure that all new components are physically and electrically compatible with the existing components and operating system.

It is always a good idea to purchase components from a reputable source and research the warranty information. Components generally fall into two categories:

- **Retail-packaged:** These components usually come with documentation, a full warranty, cables, mounting hardware, drivers, and software.
- ***Original equipment manufacturer (OEM)*:** OEM components are usually sold without packaging and require the user to locate documentation, software, drivers, and any additional hardware that might be needed. OEM components are usually less expensive and offer a shorter warranty period than similar retail packaged components. Using OEM components can result in substantial savings when upgrades are performed in bulk on many laptops, and additional support is not needed.

After completing this section, you will meet these objectives:

- Select batteries.
- Select a docking station or port replicator.
- Select storage devices.
- Select additional RAM.

Select Batteries

How do you know when you need a new laptop battery? The signs might not always be apparent, but some are obvious:

- The laptop shuts off immediately when AC power is removed
- The battery is leaking
- The battery overheats
- The battery does not hold a charge

If you experience problems that you suspect are battery-related, exchange the battery with a known good battery that is compatible with the laptop. If a replacement battery cannot be located, take the battery to an authorized repair center for testing.

A replacement battery, as shown in Figure 13-4, must meet or exceed the specifications of the laptop manufacturer. New batteries must use the same form factor as the original battery. Voltages, power ratings, and AC adapters must also meet manufacturer specifications.

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Figure 13-4 Laptop Batteries



Note

Always follow the instructions provided by the manufacturer when charging a new battery. The laptop can be used during an initial charge, but do not unplug the AC adapter. Ni-Cad and NiMH rechargeable batteries should occasionally be discharged completely to remove the charge memory. When the battery is completely discharged, it should then be charged to maximum capacity.

Caution

Always be careful when handling batteries. Batteries can explode if improperly charged, shorted, or mishandled. Be sure that the battery charger is designed for the chemistry, size, and voltage of your battery. Batteries are considered toxic waste and must be disposed of according to local laws.

Worksheet 13.3.1: Laptop Batteries

In this activity, you use the Internet, a newspaper, or a local store to gather information and then enter the specifications for a laptop battery onto this worksheet. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

Select a Docking Station or Port Replicator

Docking stations and port replicators increase the number of ports available to a laptop. A port replicator may contain a SCSI port, a networking port, PS/2 ports, USB ports, and a game port. A docking station has the same ports as a port replicator, but it adds the capability to connect to PCI cards, additional hard drives, optical drives, and floppy drives.

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Docking stations make it convenient to connect a laptop to an office network and peripherals. A laptop connected to a docking station has the same capabilities as a desktop computer. Figure 13-5 shows several docking stations and port replicators that support the same laptop.

Figure 13-5 Docking Stations and Port Replicators



Docking stations and port replicators offer several connection options:

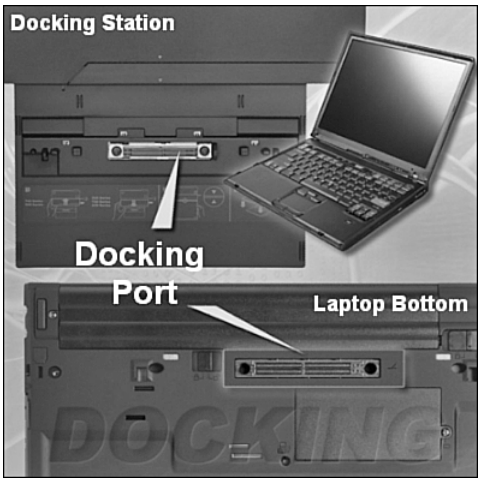
- Ethernet (RJ-45)
- Modem (RJ-11)
- ***S-Video***, TV out
- USB 2.0 port
- External monitor
- Parallel port
- High-speed serial port
- IEEE 1394 port
- Stereo headphone output
- Stereo microphone input
- Docking port

Some docking stations connect to a laptop using a docking station port that is located on the bottom of the laptop, as shown in Figure 13-6. Other docking stations are designed to plug directly into a USB port of the laptop. Most laptops can be docked when in use or while shut off. The addition of new devices when docking can be handled by using plug-and-play

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technology that recognizes and configures the newly added components, or by having a separate hardware profile for the docked and undocked state.

Figure 13-6 Docking Station Connector



Many docking stations and port replicators are proprietary and work only with particular laptops. Before buying a docking station or port replicator, check the laptop documentation or the manufacturer's website to determine the laptop's make and model.

Worksheet 13.3.2: Docking Station

In this activity, you use the Internet, a newspaper, or a local store to gather information and then enter the specifications for a laptop docking station onto this worksheet. Be prepared to discuss your decisions about the docking station you select. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

Select Storage Devices

Storage devices are CRUs, unless a warranty requires technical assistance. You have several options when adding, replacing, or upgrading a storage device for a laptop:

- ***External USB hard drive*:** An external USB hard drive connects to a laptop using the USB port. A laptop automatically detects when an external hard drive is plugged into a USB port.
- ***Firewire hard drive*:** An IEEE 1394 external hard drive that connects to the Firewire port. A laptop automatically detects when an external hard drive is plugged into a Firewire port.

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- ***DVD/CD burner*:** A DVD/CD RW drive is an optical drive that reads and writes data to and from a CD and reads data from a DVD. This is a convenient method of creating backups and archiving data. The two most common types of writable CDs and DVDs are writable (R) and rewritable (RW).

The form factor of an internal hard drive storage device is smaller for a laptop than for a desktop computer. However, the smaller drive may have a greater storage capacity.

Before purchasing a new internal or external hard drive, check the laptop documentation or the manufacturer's website for compatibility requirements. Documentation often contains Frequently Asked Questions (FAQ) that may be helpful. It is also important to research known laptop component issues on the Internet.



Worksheet 13.3.3: Research DVD Drives

In this activity, you use the Internet, a newspaper, or a local store to gather information about a DVD rewritable (DVD/RW) drive for a specified laptop. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

Select Additional RAM

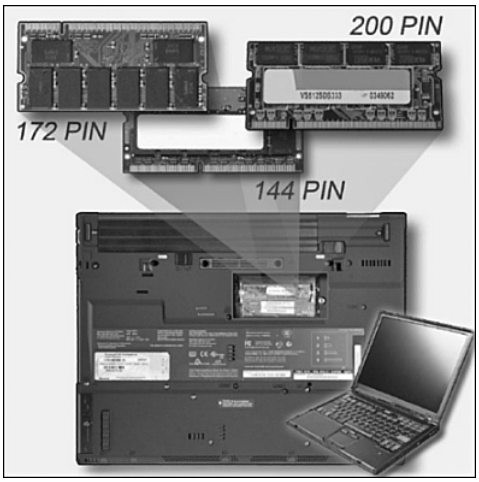
Adding RAM can optimize laptop performance. Additional RAM speeds up the process by decreasing the number of times the operating system reads and writes data to the hard drive swap file. Reading and writing data directly from RAM is faster than using swap files. Also, RAM helps the operating system run multiple applications more efficiently.

Graphic processing in laptops usually is performed by the CPU and often requires extra RAM to store the video while the CPU decodes it for viewing. New applications, such as video sharing and video editing, demand increased performance from laptops. Installing expansion RAM can help increase laptop performance.

The laptop's make and model determine the type of RAM chip needed. It is important to select the correct memory type that is physically compatible with the laptop. Most desktop computers use memory that fits into a Dual Inline Memory Module (DIMM) slot. Most laptops use a smaller profile memory chip that is called ***Small-Outline DIMM (SODIMM)*** (see Figure 13-7). SODIMMs are smaller than DIMMs, so they are ideal for use in laptops, printers, and other devices where conserving space is desirable. When replacing or adding memory, determine whether the laptop has available slots to add memory and whether the laptop supports the quantity and type of memory to be added.

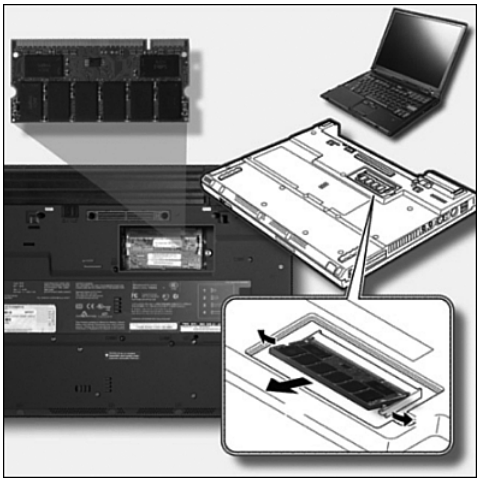
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Figure 13-7 SODIMM RAM



Before purchasing and installing additional RAM, consult the laptop documentation or the manufacturer's website for form-factor specifications. Use the documentation to find where to install RAM on the laptop. On most laptops, RAM is inserted into slots behind a cover on the underside of the case, as shown in Figure 13-8. However, on some laptops, you must remove the keyboard to access the RAM slots.

Figure 13-8 Laptop SODIMM Installation



Caution

Before installing RAM, remove the battery and unplug the computer from the electrical outlet to avoid damage related to electrostatic discharge (ESD) when you are installing memory modules.

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To confirm the currently installed amount of RAM, check the POST screen, BIOS, or System Properties window by choosing **Start > Control Panel > System** and then clicking the **General** tab. Figure 13-9 shows where the amount of RAM can be found in the System Properties window.

Figure 13-9 System Properties



Worksheet 13.3.4: Laptop RAM

In this activity, you use the Internet, a newspaper, or a local store to gather information about expansion memory for a specified laptop. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

Describe Preventive Maintenance Procedures for Laptops

Preventive maintenance should be scheduled at regular intervals to keep laptops running properly. Because laptops are portable, they are more likely than desktop computers to be exposed to these harmful materials and situations:

- Dirt and contamination
- Spills
- Wear and tear
- Drops

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- Excessive heat or cold
- Excessive moisture

In addition, properly managing data files and folders can ensure data integrity.

After completing this section, you will meet these objectives:

- Describe how to schedule and perform maintenance on laptops.
- Explain how to manage data version control between desktops and laptops.

Describe How to Schedule and Perform Maintenance on Laptops

Proper care and maintenance can help laptop components run more efficiently and extend the life of the equipment.

An effective preventive maintenance program must include a routine schedule for maintenance. Most organizations have a preventive maintenance schedule in place. If a schedule does not exist, work with the manager to create one. The most effective preventive maintenance programs require a set of routines to be conducted monthly but still allow maintenance to be performed when usage demands it.

The preventive maintenance schedule for a laptop may include practices that are unique to a particular organization, but they should also include these standard procedures:

- Cleaning
- Hard-drive maintenance
- Software updates

To keep a laptop clean, be proactive, not reactive. Keep fluids away from the laptop. Do not eat when you are working on it, and close it when it is not in use. When cleaning a laptop, never use harsh cleaners or solutions that contain ammonia. Nonabrasive materials are recommended for cleaning a laptop:

- Compressed air
- A mild cleaning solution
- Cotton swabs
- A soft, lint-free cleaning cloth

Caution

Before you clean a laptop, disconnect it from all power sources.

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Routine maintenance includes the monthly cleaning of these laptop components:

- Exterior case
- Cooling vents
- I/O ports
- Display
- Keyboard

Note

At any time, if it is obvious that the laptop needs to be cleaned, clean it. Do not wait for the next scheduled maintenance.

The operating system should also be maintained. The hard drive can become disorganized as files are opened, saved, and deleted. The computer can slow down if the operating system must search through fragmented files. Fortunately, Windows XP has two programs that help clean up the hard drive:

- Disk Cleanup
- Disk Defragmenter

How To

To Run Disk Cleanup, follow these steps:

Step 1. From My Computer, select the hard drive you want to clean.

Step 2. Right-click and choose **Properties**.

Step 3. On the General tab, click **Disk Cleanup**.

Step 4. A series of check boxes displays the files that are available for deletion, as shown in Figure 13-10. Check the boxes of the files that you want to delete, and click **OK**.

Figure 13-10 Disk Cleanup



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How To

To Run Disk Defragmenter, shown in Figure 13-11, follow these steps:

Step 1. From My Computer, select the hard drive you want to clean.

Step 2. Right-click and choose **Properties**.

Step 3. On the Tools tab, click **Defragment Now**. The length of time it takes to complete the defragmentation varies according to how fragmented the hard drive is.

Figure 13-11 Disk Defragmenter



Note

It might be necessary to close all programs running in the background before you run Disk Defragmenter.

Explain How to Manage Data Version Control Between Desktops and Laptops

It is important to manage your data files and folders properly. Restore and recover procedures, as well as backups, are more successful if the data is organized.

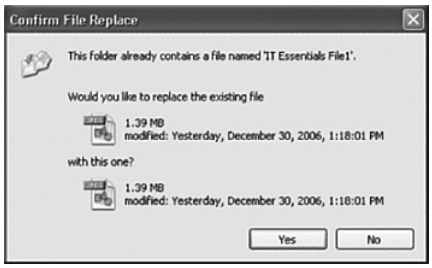
Windows XP has a default location, sometimes available as an icon on the desktop called My Documents. You can use My Documents to create a folder structure and store files.

When moving files from a laptop to a desktop computer, start by creating a similar folder structure in both locations. Files can be transferred over a network, with an optical disc, or with a portable drive.

You should be careful that data copied from one computer does not inadvertently overwrite data on the other computer. When you are copying a file to a destination folder, you might encounter a “Confirm File Replace” message, as shown in Figure 13-12.

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Figure 13-12 File Replacement Confirmation



This message indicates that Windows XP has stopped the copying process until you choose whether to replace the original file with the file that is being transferred. If you are unsure, click **No**. To determine which file to keep, compare the dates and file sizes. You may also open the files to view their content.

Note

No operating system allows files with the same name to exist in the same folder.

Caution

Be careful not to unintentionally "cut" a file from its original location when you only meant to "copy" it.

Describe How to Troubleshoot a Laptop

The troubleshooting process helps resolve problems with the laptop or peripherals. These problems range from simple ones, such as updating a drive, to more complex problems, such as installing a CPU. Use the following basic troubleshooting steps as a guideline to help diagnose and repair problems:

How To

Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

After completing this section, you will meet these objectives:

- Review the troubleshooting process.
- Identify common problems and solutions.

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Review the Troubleshooting Process

Computer technicians must be able to analyze the problem and determine the cause of the error to repair a laptop. This process is called troubleshooting.

Step 1: Gather Data from the Customer

The first step in the troubleshooting process is to gather data from the customer. Table 13-3 lists open-ended and closed-ended questions to ask the customer about laptop errors. (This list is *not* comprehensive.)

Table 13-3 Laptop Errors: Open-Ended and Closed-Ended Questions to Ask

Open-Ended Questions	Closed-Ended Questions
In what environment are you using your laptop?	Has anyone done any repair work on the laptop recently?
When did the problem start?	Has anyone else used the laptop?
What problems are you experiencing?	How does your laptop connect to the Internet?
Can you describe precisely what happens when the laptop boots?	Does your laptop have a wireless NIC?
Can you tell me anything else about the problem?	Have you ever had any problems like this before?

Step 2: Verify the Obvious Issues

After you have talked to the customer, you should verify the obvious issues that apply to laptops:

- Is the laptop plugged in?
- Is the power switch turned on?
- Have any power outages occurred?
- Are all the cables connected?
- Is the battery secure?
- Can the laptop operate with an AC power connector?
- Can the laptop operate using a battery?

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Step 3: Try Quick Solutions First

After you have checked the obvious issues, try some quick solutions:

- Replace the AC power adapter with a known good AC power adapter.
- Remove and reinsert the battery.
- Replace the battery with a known good battery.

Step 4: Gather Data from the Computer

If quick solutions do not correct the problem, it is time to gather data from the computer. Here are some different ways to gather information about the problem from the laptop:

- Error messages
- Beep sequences
- LEDs
- POST

Step 5: Evaluate the Problem and Implement the Solution

At this point, you have enough information to evaluate the problem and to research and implement possible solutions. Here are some resources for possible solutions:

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

Step 6: Close with the Customer

After you have solved the problem, you close with the customer, which requires completing the following tasks:



Step 1. Discuss the solution implemented with the customer.

Step 2. Have the customer verify that the problem has been solved.

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Step 3. Provide the customer with all paperwork.

Step 4. Document the steps taken to solve the problem in the work order and the technician's journal.

Step 5. Document any components used in the repair.

Step 6. Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Laptop problems can be attributed to hardware, software, networks, or some combination of the three. You will resolve some types of laptop problems more often than others. Table 13-4 describes common laptop problems and solutions.

Table 13-4 Common Problems and Solutions

Problem Symptom	Possible Solution
A laptop user complains that the numerous peripheral cables are constantly getting tangled.	Provide information to the user about cordless peripherals.
A laptop user is unable to connect to the wireless network.	Reconfigure the wireless security on the laptop to connect to the security system used by the network.
The laptop keyboard no longer works.	The keyboard is a FRU. Advise the customer to take the laptop to a repair center or return it to the manufacturer.
A user reports that the laptop battery needs recharging more frequently than when it was new.	Have the user completely discharge the battery and then fully recharge it.
A user obtains a new laptop and reports that it does not fit in the existing docking station.	Docking stations are proprietary. Verify that the user has a compatible model.



Worksheet 13.5.3: Verify Work Order Information

In this worksheet, a level-two call center technician finds creative ways to verify information that the level-one tech has documented in the work order. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may complete this worksheet now or wait to do so until the end of the chapter.

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Summary

This chapter has described components of laptops and portable devices. Here are some important concepts contained in this chapter:

- Bluetooth creates a small wireless PAN for connected cell phones, printers, and laptops.
- An IR network uses infrared light to create short-range networks that are primarily used to control input devices and mobile devices.
- A cellular WAN allows you to use your cell phone and laptop for voice and data communications.
- The most popular wireless technology is Wi-Fi. The four major Wi-Fi releases, each with different speed and bandwidth ratings, are IEEE 802.11 a, b, g, and n.
- Satellite networks are faster than modems but slower than DSL and cable networks. Satellite networks are primarily used in remote locations.
- A CRU is a component that a user can easily install without technical training.
- A FRU is a component that a trained service technician may install at a remote location.
- Most repairs can be done at customers' sites or at any local repair center. However, on some occasions a laptop must be sent to the manufacturer for repairs.
- Professional technicians follow preventive maintenance schedules to keep their equipment at optimal performance levels.
- Laptops are more susceptible to contamination and damage. A well-maintained laptop reduces repair costs.
- A docking station allows a laptop to easily connect to peripheral devices similar to those found on desktop computers. A port replicator can be added to a laptop if the user needs more I/O ports.
- Mastering the steps in troubleshooting laptop problems is considered a career milestone by many technicians.
- A well-trained technician must possess good customer communication skills.

Summary of Exercises

This is a summary of the Labs, Worksheets, Remote Technician exercises, Class Discussions, Virtual Desktop activities, and Virtual Laptop activities associated with this chapter.

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Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Worksheet 13.2.0: Investigating Repair Centers

Worksheet 13.3.1: Laptop Batteries

Worksheet 13.3.2: Docking Station

Worksheet 13.3.3: Research DVD Drive

Worksheet 13.3.4: Laptop RAM

Worksheet 13.5.3: Verify Work Order Information

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Which IEEE specification defines WPAN technology?

   A. 802.3.1
   B. 802.5.1
   C. 802.7.5
   D. 802.11.1
   E. 802.13.5
   F. 802.15.1

2. Which IEEE specification defines Wi-Fi technology?

   A. 802.3
   B. 802.5
   C. 802.7
   D. 802.11
   E. 802.13
   F. 802.15

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3. Which two battery characteristics must you consider when choosing a replacement for a laptop?

   A. Brand
   B. Charging time
   C. Color
   D. Size
   E. Voltage

4. Which IEEE specification defines the Firewire standard?

   A. 1284
   B. 1294
   C. 1384
   D. 1394

5. After you resolve a computer problem, what is the next step in the troubleshooting process?

   A. Inform the supervisor.
   B. Test other components randomly.
   C. Cancel the work order.
   D. Reevaluate the problem.
   E. Close with the customer.

6. Which two Windows utilities can be used to help maintain hard disks on computers that have had long periods of normal use?

   A. Disk Cleanup
   B. Disk Maintenance
   C. Disk Defragmenter
   D. Disk Partition
   E. Disk Format

7. What acronym refers to the name given to laptop parts that can be easily replaced by end users?

   A. CRU
   B. FRU
   C. NRU
   D. SRU

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8. Which two materials are recommended for use when you clean a laptop?

A. Diluted ammonia
B. Compressed air
C. Cotton balls
D. Detergent
E. Isopropyl alcohol
F. Mild cleaning solutions

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CHAPTER 14

Advanced Printers and Scanners

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- What are the potential safety hazards and safety procedures associated with printers and scanners?
- How do I install and configure a local printer and scanner?
- How do I share a printer and a scanner on a network?
- What does it take to upgrade and configure printers and scanners?
- What are some good printer and scanner preventive maintenance techniques?
- How can I troubleshoot printers and scanners?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

fuser assembly *page xx*

serial *page xx*

parallel *page xx*

SCSI *page xx*

USB *page xx*

FireWire *page xx*

Ethernet *page xx*

printer driver installation *page xx*

Page Description Language (PDL) *page xx*

Printer Command Language (PCL) *page xx*

PostScript (PS) *page xx*

Graphics Device Interface (GDI) *page xx*

scanner calibrations *page xx*

print servers *page xx*

network print server devices *page xx*

dedicated PC print server *page xx*

shared printers *page xx*

transfer rollers *page xx*

separation pads *page xx*

pickup rollers *page xx*

printer maintenance *page xx*

HEPA filtration *page xx*

scanner maintenance *page xx*

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This chapter explores the functionality of printers and scanners. You will learn how to maintain, install, and repair these devices in both local and network configurations. The chapter discusses safety hazards, configuration procedures, preventive maintenance, and printer and scanner sharing.

Describe Potential Safety Hazards and Safety Procedures Associated with Printers and Scanners

You must always follow safety procedures when working on any computer. There are also rules that you must follow as you work with printers and scanners. These rules keep you and the equipment safe.

The first rule of safety concerns moving large pieces of equipment. Always lift equipment by using the strength in your legs and knees, not your back. Wear appropriate work clothes and shoes. Do not wear loose jewelry or baggy clothes when servicing computer equipment.

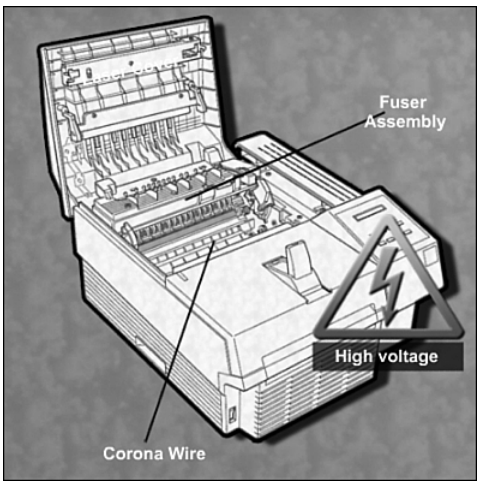
Printers, scanners, and all-in-one devices that connect to AC outlets can become hot while in use. If you plan to perform any services on equipment, you should turn it off and allow it to cool before beginning any repairs on internal components. Print heads on dot matrix printers can become very hot when in use. The ***fuser assembly*** on a laser printer can also become hot.

Some printers retain a large amount of voltage even after you disconnect them from a power source. Only qualified technicians should perform advanced repairs on laser printers, particularly if the repair involves the corona wire or transfer roller assembly, as shown in Figure 14-1. These areas can retain high voltage, even after the printer has been turned off. Check the service manuals or contact the manufacturer to be sure that you know where these areas are inside the devices.

Printers and scanners can be expensive. If you do not service printers correctly, or if you install the wrong part, you can damage them beyond repair.

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Figure 14-1 Laser Printer Hazards



Install and Configure a Local Printer and Scanner

A local device is one that connects directly to the computer. Before you install a local device, such as a printer or scanner, be sure that you remove all packing material. Take out anything that prevents moving parts from shifting around during shipping. Keep the original packing material in case you need to return the equipment to the manufacturer for warranty repairs.

General printer and scanner installation is as follows:

How To

Step 1. Connect the device (USB, FireWire [IEEE 1394], LPT [IEEE 1284], Serial [RS232], Printer Server).

Step 2. Use Windows XP's PnP driver.

Step 3. Add software from the manufacturer.

Step 4. Check for driver updates on the Internet.

Step 5. Change default settings.

Step 6. Make a test print.

Step 7. Scan a picture.

Step 8. Print the scanned picture.

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After completing this section, you will meet the following objectives:

- Connect the device to a local port
- Install and configure the driver and software
- Configure options and default settings
- Verify functionality

Connect the Device to a Local Port

Depending on the manufacturer, local printers can communicate with computers using serial, parallel, USB, FireWire, or SCSI ports and cables. Wireless technologies, such as Bluetooth and infrared, are also used to connect these devices. Review the characteristics of these ports:

- ***Serial***: Serial data transfer is the movement of single bits of information in a single cycle. A serial connection can be used for dot matrix printers because the printers do not require high-speed data transfer.
- ***Parallel***: Parallel data transfer is faster than serial data transfer. Parallel data transfer is the movement of multiple bits of information in a single cycle. The path is wider for information to move to or from the printer. IEEE 1284 is the current standard for parallel printer ports. Enhanced Parallel Port (EPP) and Enhanced Capabilities Port (ECP) are two modes of operation that allow bidirectional communication.
- ***SCSI***: There are several types of SCSI, including the following common types:
  - SCSI 1: 50-pin connector
  - SCSI 2 (fast SCSI): 50-pin connector
  - SCSI 2 (wide SCSI): 68-pin connector
  - SCSI 3 (fast/wide SCSI): 68-pin connector

  SCSI printers and computers require the proper cabling for the ports. These ports can be DB 50, Mini DB 50, and DB 68. All of these ports can be male or female.
- ***USB***: USB is a common interface for printers and other devices. The speed and simple setup have made USB very practical. Newer operating systems offer Plug and Play (PnP) USB support. When a USB device is added to a computer system supporting PnP, the device is automatically detected, and the computer starts the driver installation process.
- ***FireWire***: FireWire, also known as i.LINK or IEEE 1394, is a high-speed communication bus that interconnects digital devices such as printers, scanners, cameras, and hard drives, among others. FireWire provides a single plug-and-socket connection on which up to 63 devices can be attached with data transfer speeds up to 400 Mbps.

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- ***Ethernet***: Printers can be shared over a network. Connecting a printer to the network requires cabling that is compatible with both the existing network and the network port installed in the printer. Most network printers use an RJ-45 interface to connect to a network.

To connect a printer, attach the appropriate cable to the communication port on the back of the printer. Connect the other end of the cable to the corresponding port on the back of the computer.

After the data cable has been properly connected, attach the power cable to the printer. Connect the other end of the power cable to an available electrical outlet. When you turn on the power to the device, the computer tries to determine the correct device driver to install.

Tip

Always check the packaging for cables when you buy a printer or scanner. Many manufacturers keep production costs down by not including a cable with the printer. If you have to buy a cable, be sure that you buy the correct type.

Install and Configure the Driver and Software

Printer drivers are software programs that make it possible for computers and printers to communicate with each other. Configuration software provides an interface that enables users to set and change printer options. Every printer model has its own type of driver and configuration software.

When you connect a new printer device to a computer, Windows XP tries to locate and install a default driver by using the PnP utility. If Windows cannot find the necessary driver on the computer, it tries to connect to the Internet to find one. Printer manufacturers frequently update drivers to increase the performance of the printer, to add new and improved printer options, and to address general compatibility issues.

Printer Driver Installation

The ***printer driver installation*** and updating process usually involves the following five steps:

How To

Step 1. Determine the current version of the installed printer driver. Remember to select a newer version to increase functionality.

Step 2. Search the Internet to locate the most recent version of the driver.

Step 3. Download the driver. Follow the instructions on the website.

Step 4. Install the driver. When activated, most driver installation programs automatically install the new driver.

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Step 5. Test the driver. To test the driver, choose **Start** > **Settings** > **Printers and Faxes.** Right-click the printer and choose **Properties.** Then choose **Print Test Page.** If the printer does not work, restart the computer and then try again.

The printed test page should contain text that you can read. If the text is unreadable, the problem could be a bad driver or that the wrong Page Description Language has been used.

Page Description Language (PDL)

A ***Page Description Language (PDL)*** is a type of code that describes the appearance of a document in a language that a printer can understand. The PDL for a page includes the text, graphics, and formatting information. Software applications use PDLs to send What You See Is What You Get (WYSIWYG) images to the printer. The printer translates the PDL file so that whatever is on the computer screen is what is printed. PDLs speed the printing process by sending large amounts of data at one time. PDLs also manage the computer fonts.

There are three common PDLs:

- ***Printer Command Language (PCL)***: Hewlett-Packard developed PCL for communication with early inkjet printers. PCL is now an industry standard for nearly all printer types.
- ***PostScript (PS)***: Adobe Systems developed PS to allow fonts or text types to share the same characteristics on the screen as on paper.
- ***Graphics Device Interface (GDI)***: GDI is a Windows component that manages how graphical images are transmitted to output devices. GDI works by converting images to a bitmap that uses the computer instead of the printer to transfer the images.

Table 14-1 compares PostScript to PCL.

Table 14-1 PostScript Versus PCL

PostScript	PCL
Page is rendered by the printer.	Page is rendered on the local workstation.
Better quality output.	Faster print jobs.
Handles more complex print jobs.	Requires less printer memory.
Used on Mac OS.	Not supported by Mac OS.
Output is identical on different printers.	Output varies slightly on different printers.

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Configure Options and Default Settings

Common printer options that can be configured by the user include media control and printer output.

The following media control options set the way a printer manages media:

- Input paper tray selection
- Output path selection
- Media size and orientation
- Paper weight selection

The following printer output options manage how the ink or toner goes on the media:

- Color management
- Print speed

Some printers have control switches for users to select options. Other printers use the printer driver options. Two methods of selecting options are the global and per-document methods, as described in the sections that follow.

Global Printer Options

The global method refers to printer options that are set to affect all documents. Each time a document is printed, the global options are used, unless overridden by per-document selections.

To change the configuration of a global printer, choose **Start** > **Control Panel** > **Printers and Faxes** and right-click the printer. The following examples show how you can manage printer options.

To designate a default printer, choose **Start** > **Control Panel** > **Printers and Faxes**. Right-click the printer, and then choose **Set as Default Printer**, as shown in Figure 14-2.

Note

Depending on the driver installed, Set as Default Printer might not appear on the menu. If this happens, double-click the printer to open the Document Status window and then choose **Printer** > **Set as Default Printer**.

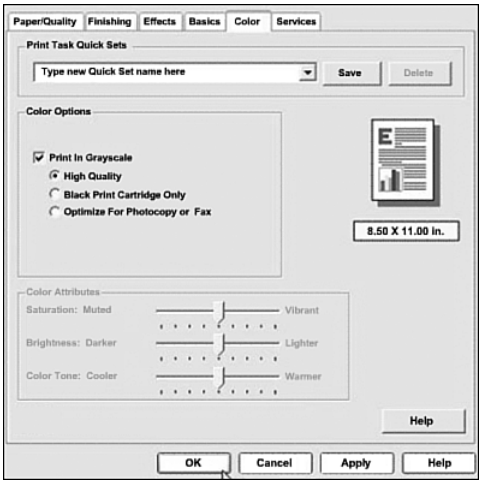
To limit printing to only black and white, choose **Start** > **Control Panel** > **Printer and Faxes**. Right-click the printer, and then choose **Printing Preferences**. Choose the Color tab. Select the **Print In Grayscale** check box and choose the **Black Print Cartridge Only** radio button in the window shown in Figure 14-3. Click **OK**.

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Figure 14-2 Selecting a Default Printer



Figure 14-3 Set Color Options



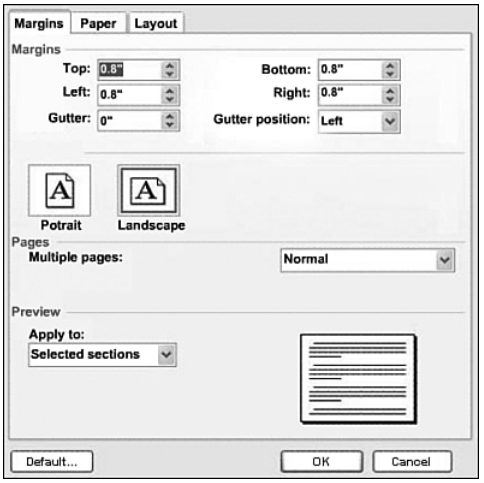
Per-Document Printer Options

Letters, spreadsheets, and digital images are some of the document types that can require special printer settings. You can change the settings for each document sent to the printer by changing the document print settings.

To change the printer settings, keep the document open and choose **File** > **Print** > **Properties.** The default settings are displayed, as shown in Figure 14-4. You can alter the colors, print quality, paper direction, and margin size for the document that you are printing without changing the default settings.

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Figure 14-4 Changing the Printer Settings on a Per-Document Basis



Scanner Calibrations

Calibrating a device is one of the first tasks after installing a driver. Use the bundled software that came with the device to perform this procedure. The default settings can be altered later to meet customer requirements.

Scanner calibrations can include positioning the sensor and using an IT8 target to adjust the color. An IT8 target is a color calibration chart that you use to create profiles for specific devices. A scanner analyzes the target for comparison, while a printer reproduces the target for comparison.

To ensure calibration, compare the printed output of the device to the IT8 target. Adjust the printer color settings to match. The next time you print or scan an image, the color will be as accurate as the target.

Printer Calibrations

The calibration of the printer is performed using the print driver software. This process makes sure that the print heads are aligned and can print on special paper. Inkjet print heads are usually fitted to the ink cartridge, which means that you might have to recalibrate the printer each time you change a cartridge.

Verify Functionality

The installation of any device is not complete until you have successfully tested all the device functions. This includes special tasks such as the following:

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- Printing double-sided documents to save paper
- Using different types of paper trays for special paper sizes
- Changing the settings of a color printer so that it prints in black and white or grayscale to print draft copies of documents
- Printing in draft mode to save ink
- Changing a scanner's resolution to make an image easier to view
- Editing scanned images of saved documents
- Using an optical character recognition (OCR) application

Note

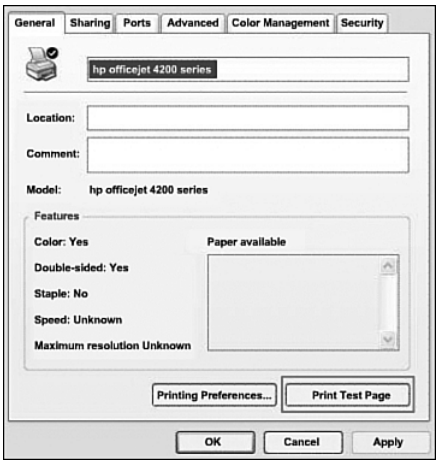
Electronic manuals and support websites explain how to clear paper jams, install ink cartridges, and load all types of paper trays.

Printer Test

There are several ways to print a test page:

- Using the Print Test Page option from the printer
- Using the Print Test Page option from Windows, as shown in Figure 14-5
- Using the print function of an application
- Sending a file directly to a parallel port printer using the command line

Figure 14-5 Print Test Page



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To test a printer, first print a test page from the printer and then print from the printer properties function or from an application. To get to the printers properties, choose **Start** > **Printer and Faxes** > *(select your printer)* > **Print** > **Properties** > **Print Test Page**. This ensures that the printer is working properly, that the driver software is installed and working, and that the printer and computer are communicating.

Scanner Test

Test the scanner by scanning a document. Use the buttons on the device for automatic scanning. Next, initiate scans from the scanner software and make sure that the software opens automatic scan. If the scanned images appear to be the same as the image on the screen, you have successfully completed the installation.

For an all-in-one device, you should test all the functions:

- Fax: Fax to another known working fax machine
- Copy: Create a copy of a document
- Scan: Scan a document
- Print: Print a document



Lab 14.2.4: Install an All-in-One Printer/Scanner

In this lab, you will check the Windows XP Hardware Compatibility List (HCL) for the Epson Stylus CX7800, install the all-in-one printer/scanner, upgrade the driver and any associated software, and test the printer and scanner. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Describe How to Share a Printer and a Scanner on a Network

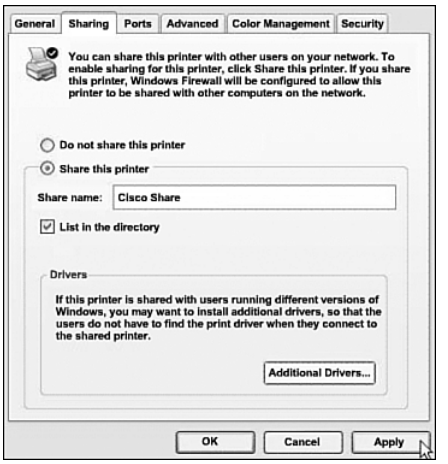
One of the primary reasons that networks were developed was to allow groups of computer users to share peripheral devices. The most common shared device is the printer. Sharing a single printer among a group of users costs much less than buying a printer for each computer.

Low-cost printers usually require a separate print server to allow network connectivity because these printers do not have built-in network interfaces. The computer that is connected to the printer can serve as the print server. Most personal computer operating systems have built-in printer sharing capability.

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After you confirm that the printer-sharing software is installed, the server must know which printer it is going to share. From the Control Panel, select **Printers and Faxes**, right-click the printer to share, and select **Sharing** from the resulting drop-down menu. Select the **Share this printer** option, as shown in Figure 14-6, and assign the printer a name.

Figure 14-6 Shared Printer



After completing this section, you will meet these objectives:

- Describe the types of print servers
- Describe how to install network printer software and drivers on a computer

Describe the Types of Print Servers

Print servers enable multiple computer users to access a single printer. A print server has three functions:

- To provide client access to print resources
- To administrate print jobs, storing them in a queue until the print device is ready for them, and then feeding or spooling the print information to the printer
- To provide feedback to the users, including providing notification that a print job is finished, or error messages that something has gone wrong

As a technician, you must choose one of the three types of print server that best suits the customer's needs:

- Network print server devices
- Dedicated PC print servers
- Computer-shared printers

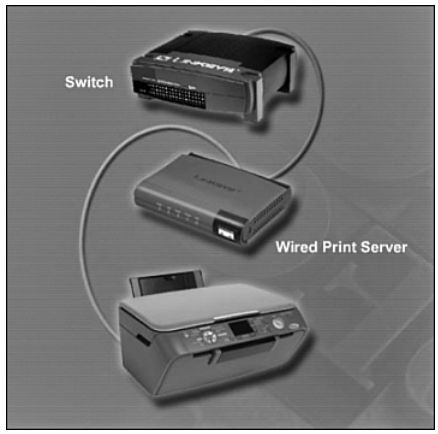
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Network Print Server Devices

Network print server devices allow many users on a network to access a single printer. A network print server device can manage network printing through either wired or wireless connections. Figure 14-7 shows a wired print server. You should consider the advantages and disadvantages of a dedicated PC print server before you install one:

- An advantage of using a network print server is that the server accepts incoming print jobs from computers, and then frees the computers for other tasks. The print server is always available to the users, unlike a printer shared from a user's computer.
- A disadvantage of a network print server is that it might not be able to use all the functions of an all-in-one device.

Figure 14-7 Network Print Server Device



Dedicated PC Print Servers

A ***dedicated PC print server*** is a computer dedicated to handling client print jobs in the most efficient manner. Because it handles requests from multiple clients, a print server is usually one of the most powerful computers on the network. Dedicated PC print servers can manage more than one printer at a time. A print server needs to have resources available to meet the requests of print clients:

- **Powerful processor**: Because the PC print server uses its processor to manage and route printing information, it needs to be fast enough to handle all incoming requests.
- **Adequate hard disk space**: A PC print server captures print jobs from clients, places them in a print queue, and sends them to the printer in a timely way. This requires the computer to have enough storage space to hold these jobs until completed.
- **Adequate memory**: The server processor and RAM handle sending print jobs to a printer. If server memory is not large enough to handle an entire print job, the hard drive must send the job, which is much slower.

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Computer-Shared Printers

A user's computer that has a printer attached can share that printer with other users on the network. Windows XP makes the process of enabling ***shared printers*** fast and easy. In a home network, it means that users can print documents from wherever they are in the house by using a wireless laptop. In a small office network, sharing a printer means one printer can serve many users.

Sharing a printer from a computer also has disadvantages. The computer sharing the printer uses its own resources to manage the print jobs coming to the printer. If a user on the desktop is working at the same time that a user on the network is printing, the desktop user might notice a performance slowdown. In addition, the printer is not available if the user reboots or powers down the computer with a shared printer.

Describe How to Install Network Printer Software and Drivers on a Computer

Windows XP allows computer users to share their printers with other users on the network. There are two steps:

How To

Step 1. Configure the computer attached to the printer to share the printer with other network users.

Step 2. Configure a user's computer to recognize the shared printer and print to it.

To configure the computer with the printer attached to accept print jobs from other network users, follow these steps:

How To

Step 1. Choose **Start** > **Control Panel** > **Printers and Other Hardware** > **Printers and Faxes**.

Step 2. Select the printer you want to share.

Step 3. The Printer Tasks dialog box will appear on the left. Select **Share this printer**.

Step 4. The Printer Properties dialog box for that printer will display. Select the Sharing tab. Select **Share this printer** and enter the desired share name. This is the name that the printer will appear as to other users.

Step 5. Verify that sharing has been successful. Return to the Printers and Faxes folder and notice that the printer icon now has a hand under it, as shown in Figure 14-8. This shows that the printer is now a shared resource.

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Figure 14-8 Shared Printer Icon



Other users who can now connect to the shared printer might not have the required drivers installed. These other users might also be using different operating systems than the computer that is hosting the shared printer. Windows XP can automatically upload the correct drivers to these other users. Click the **Additional Drivers** button to select operating systems that the other users might be using. When you close that dialog box by clicking **OK**, Windows XP will ask whether you want to obtain those additional drivers. If all the other users are also operating Windows XP, you do not need to click the **Additional Drivers** button. To find the additional drivers button, choose **Start**>**Printers and Faxes**, right-click the printer you are sharing, and choose **Properties**>**Sharing**>**Additional Drivers** button.

Other users on the network can now connect to this printer by following these steps:

How To

Step 1. Choose **Start** > **Control Panel** > **Printers and other Hardware** > **Add a Printer**.

Step 2. The Add Printer Wizard appears. Click **Next**.

Step 3. Select **A network printer, or a printer attached to another computer**, as shown in Figure 14-9. Click **Next**.

Step 4. Type in the name of the printer, or browse for it on the network using the **Next** button. A list of shared printers will appear.

Step 5. After you select the printer, a virtual printer port is created and displayed in the Add a Printer window. The required print drivers are downloaded from the print server and installed on the computer. The wizard then finishes the installation.

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Figure 14-9 Connecting to a Shared Printer



Lab 14.3.2: Share the All-in-One Printer/Scanner

In this lab, you will share the Epson printer/scanner, configure the printer on a networked computer, and print a test page from the remote computer. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Upgrade and Configure Printers and Scanners

Some printers can be expanded to print faster and to accommodate more print jobs by adding hardware. The hardware can include additional paper trays, sheet feeders, network cards, and expansion memory.

Scanners can also be configured to do more to meet customer needs. Examples for scanner optimization include color correction and resizing. These tasks cannot be completed with the default settings.

After completing this section, you will meet these objectives:

- Describe printer upgrades
- Describe scanner optimization

Describe Printer Upgrades

Upgrading the printer memory improves the printing speed and enhances the ability to perform complex print jobs. All printers today have at least a small amount of RAM. The more

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memory a printer has, the more efficiently it works. The added memory helps with tasks such as job buffering, page creation, improved photo printing, and graphics.

Print job buffering is when a print job is captured into the internal printer memory. Buffering allows the computer to continue with other work instead of waiting for the printer to finish. Buffering is a common feature in laser printers and plotters, as well as in advanced inkjet and dot matrix printers.

Printers usually arrive from the factory with enough memory to handle jobs that involve text. However, print jobs involving graphics, and especially photographs, run more efficiently if the printer memory is adequate to store the entire job before it starts. If you receive errors that indicate the printer is "out of memory" or that there has been a "memory overload," you might need more memory.

Installing Printer Memory

The first step in installing additional printer memory is to read the printer manual to determine the following:

- **Memory type**: Physical type of memory, speed, and capacity; some are standard types of memory, whereas others require special or proprietary memory.
- **Memory population and availability**: Number of memory upgrade slots in use, and how many are available; this can require opening a compartment to check RAM.

Printer manufacturers have set procedures for upgrading memory, including the following tasks:

- Removing covers to access the memory area
- Installing or removing memory
- Initializing the printer to recognize the new memory
- Installing updated drivers if needed

Additional Printer Upgrades

Some additional printer upgrades include the following:

- Duplex printing to enable dual-sided printing
- Extra trays to hold more paper
- Specialized tray types for different media
- Network cards to access a wired or wireless network
- Firmware upgrades to add functionality or to fix bugs

Follow the instructions included with the printer when you install or upgrade components. Contact the manufacturer or an authorized service technician for additional information if

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you have any problems when installing upgrades. Follow all safety procedures outlined by the manufacturer.

Describe Scanner Optimization

Scanners work well for most users without any changes to the default settings. There are, however, features that can improve document or image scans depending on user requirements. The most common types of scanner options are as follows:

- Resizing
- Sharpening
- Brightening or darkening
- Color correction
- Resolution changes
- Output file format
- Color inversion

Scanning resolution affects the size of the output file. The end use of the image determines the required resolution. If the image is for use on a web publication, you only need low resolution and a small file size. This makes it possible for browsers to load the image quickly. Medium-resolution images are normally used for laser prints. In commercial printing, where the quality of the image is very important, a higher resolution is the best setting. Low resolution means a small file size; high resolution means a large file size. Figure 14-10 shows the settings for resolution and output type.

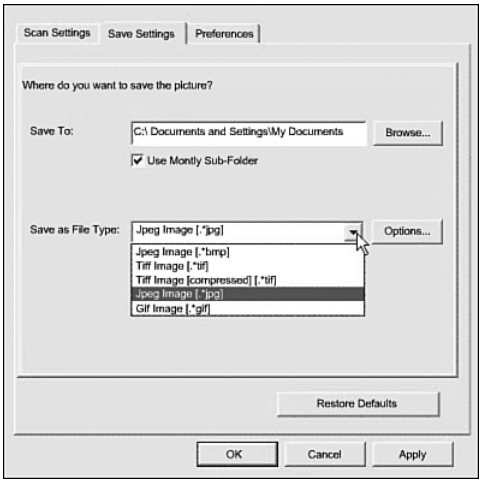
Figure 14-10 Resolution Settings



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Scanners can allow you to choose different file formats for the scanned output, as shown in Figure 14-11.

Figure 14-11 Output Options



If a scanner does not produce output in a file format required by the customer, the format can be converted later using software tools. After changing device settings, you should test the changes by making some sample printouts.



Lab 14.4.2: Optimize Scanner Output

In this lab, you will scan a picture at two different levels of dots per inch (DPI). The results will be displayed and compared on your monitor as two saved files and as two printed images. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Describe Printer and Scanner Preventive Maintenance Techniques

Preventive maintenance decreases downtime and increases the service life of the components. You should maintain printers and scanners to keep them working properly. A good maintenance program guarantees good-quality prints and scans. The printer or scanner manual contains information on how to maintain and clean the equipment.

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After completing this section, you will meet these objectives:

- Determine scheduled maintenance according to vendor guidelines
- Describe a suitable environment for printers and scanners
- Describe cleaning methods
- Describe how to check the capacity of ink cartridges and toners

Determine Scheduled Maintenance According to Vendor Guidelines

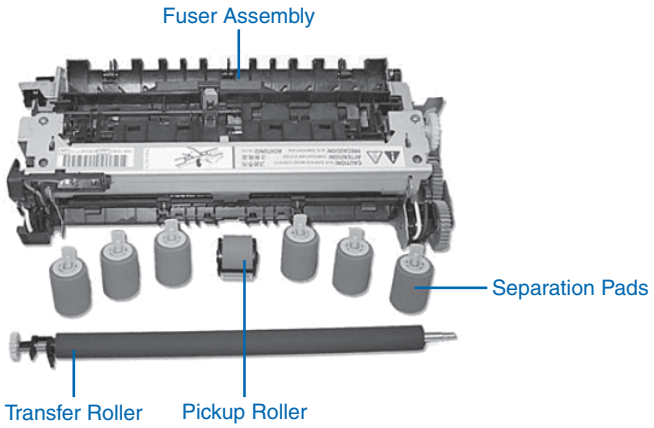
Read the information manuals that come with every new piece of equipment. Follow the recommended maintenance instructions. Also, use the supplies listed by the manufacturer. Less expensive supplies can save money but might produce poor results, damage the equipment, or void the warranty.

When maintenance is completed, reset the counters to allow the next maintenance to be completed at the correct time. On many types of printers, the page count is viewed through the LCD or a counter located inside the main cover.

Most manufacturers sell maintenance kits for their printers. Figure 14-12 shows a sample maintenance kit. The kit has instructions that any technician can follow. For laser printers, the kit can contain replacement parts that often break or wear out:

- Fuser assembly
- ***Transfer rollers***
- ***Separation pads***
- ***Pickup rollers***

Figure 14-12 Maintenance Kit



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Each time you install new parts or replace toners and cartridges, do a visual inspection of all the internal components:

- Remove bits of paper and dust.
- Clean spilled ink.
- Look for any worn gears, cracked plastic or broken parts.

Users that do not know how to maintain printing equipment should call a manufacturer-certified technician.



Worksheet 14.5.1: Search for Certified Printer Technician Jobs

For this worksheet, you will use the Internet to gather information about becoming a certified printer technician. Be prepared to discuss your answers with the class. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can complete this worksheet now or wait to do so until the end of the chapter.

Describe a Suitable Environment for Printers and Scanners

Printers and scanners, like all other electrical devices, are affected by temperature, humidity, and electrical interference. For example, laser printers produce heat. Operate them in well-ventilated areas to prevent overheating. If possible, store all printers, scanners, and supplies in a cool and dry place, away from dust. This will ensure that they will work properly and for a long time.

Keep paper and toner cartridges in their original wrappers and in a cool, dry environment. High humidity causes paper to absorb moisture from the air. This makes it difficult for the toner to attach to the paper correctly. If the paper and printer are dusty, you can use compressed air to blow away the dust.

Operating environment guidelines are as follows:

- Keep paper dry.
- Keep printer in a cool, dust-free environment.
- Store toner in a clean, dry environment.
- Clean glass on scanners.

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Describe Cleaning Methods

Always follow the manufacturer's guidelines when cleaning printers and scanners. Information on the manufacturer's website or in the user manual explains the proper cleaning methods.

Caution

Remember to unplug scanners and printers before cleaning to prevent danger from high voltage.

Printer Maintenance

Make sure that you turn off and unplug any printer before performing ***printer maintenance***. Use a damp cloth to wipe off any dirt, paper dust, and spilled ink on the exterior of the device.

Print heads in an inkjet printer are replaced when the cartridges are replaced. However, sometimes print heads become clogged and require cleaning. Use the utility supplied by the manufacturer to clean the print heads. After you clean them, you should test them. Repeat this process until the test shows a clean and uniform print.

Printers have many moving parts. Over time, the parts collect dust, dirt, and other debris. If not cleaned regularly, the printer might not work well, or could stop working. When working with dot matrix printers, clean the roller surfaces with a damp cloth. On inkjet printers, clean the paper-handling machinery with a damp cloth.

Caution

Do not touch the drum of a laser printer while cleaning. You can damage the surface of the drum.

Laser printers do not usually require much maintenance unless they are in a dusty area or they are very old. When cleaning a laser printer, use a specially designed vacuum cleaner to pick up toner particles. Figure 14-13 shows a vacuum designed for electronic equipment. A standard vacuum cleaner cannot hold the tiny particles of toner and can scatter them about. Use only a vacuum cleaner with ***HEPA filtration***. HEPA filtration catches microscopic particles within the filters.

Choosing the correct paper type for a printer helps the printer last longer and print more efficiently. Several types of paper are available. Each type of paper is clearly labeled with the type of printer for which it is intended. The manufacturer of the printer might also recommend the best type of paper. Check the printer manual.

Information about the brands and types of ink recommended by the manufacturer is also found in the manual. Using the wrong type of ink can cause the printer not to work or can reduce the print quality. To prevent ink leaks, do not refill ink cartridges.

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Figure 14-13 Printer Vacuum



Scanner Maintenance

For proper ***scanner maintenance***, you should clean scanners regularly to prevent dirt, fingerprints, and other smudges from showing in scanned images. On flatbed scanners, keep the lid closed when the scanner is not in use. This will help to prevent dust buildup and accidental fingertip smudges. If the glass becomes dirty, consult the user guide for the manufacturer's cleaning recommendations. If the manual does not list any recommendations, use a glass cleaner and a soft cloth to protect the glass from scratching. Even very small scratches can be visible on high-resolution scans. If dirt becomes lodged in the scratches, the scratches will become more visible.

If the inside of the glass becomes dirty, check the manual for instructions on how to open the unit or remove the glass from the scanner. If possible, thoroughly clean both sides and replace the glass as it was originally installed in the scanner.

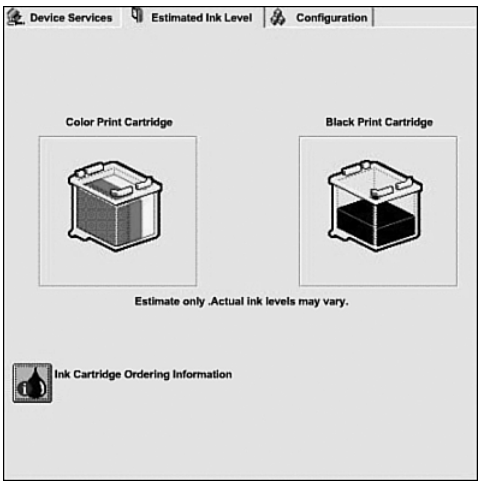
Describe Checking Capacity of Ink Cartridges and Toners

When an inkjet printer produces blank pages, the ink cartridges can be empty. Laser printers, however, do not produce blank pages, but do begin to print very poor-quality printouts. Most inkjet printers provide a utility that shows ink levels in each cartridge, as shown in Figure 14-14. Some printers have LCD message screens or LED lights that warn users when ink supplies are low.

A method for checking ink levels is to look at the page counter inside the printer or the printer software to determine how many pages have been printed. Then look at the cartridge label information. The label should show how many pages the cartridge can print. You can then easily estimate how many more pages you can print. For this method to be accurate, each time you replace the cartridge, you must remember to reset the counter. In addition, some printouts use more ink than others do. For example, a letter uses less ink than a photograph.

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Figure 14-14 Estimated Ink Level



You can set the printer software to reduce the amount of ink or toner that the printer uses. This setting might be called “toner save” or “draft quality.” This setting reduces the print quality of laser and inkjet products and reduces the time it takes to print a document on an inkjet printer.

Troubleshoot Printers and Scanners

With printer and scanner problems, a technician must be able to determine whether the problem exists with the device, cable connection, or the computer that it is attached to. Follow the steps outlined in the following sections to accurately identify, repair, and document the problem.

How To

Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

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After completing this section, you will meet these objectives:

- Review the troubleshooting process
- Identify common problems and solutions
- Apply troubleshooting skills

Review the Troubleshooting Process

Printer and scanner problems can result from a combination of hardware, software, and connectivity issues. Computer technicians must be able to analyze the problem and determine the cause of the error to address the printer and scanner issues.

Step 1: Gather Data from the Customer

The first step in the troubleshooting process is to gather data from the customer. Table 14-2 provides a list of open-ended and closed-ended questions to ask the customer about printer/scanner errors. (This list is *not* comprehensive.)

Table 14-2 Printer/Scanner Errors: Open-Ended and Close-Ended Questions to Ask

Open-Ended Questions	Closed-Ended Questions
What type of printer/scanner do you have?	Does the problem appear on every page?
What type of paper are you using?	Has the paper been changed recently?
What problems are you experiencing with this printer/scanner?	How old is the printer/scanner?
What error messages have you received?	Is the problem only with this printer/scanner?
What changes have been made recently?	What application were you using?
What have you done to maintain the printer/scanner?	Does the problem occur when you use other applications?
	What make and model of printer/scanner is it?
	Is the printer/scanner local or networked?
	What is the location of the printer/scanner?

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Step 2: Verify the Obvious Issues

After you have talked to the customer, you should verify the obvious issues. Issues that apply to printers and scanners include

- Check that the data cable is the correct cable and installed correctly.
- Make sure that the printer is not plugged into an uninterruptible power source (UPS).
- Check that the glass surfaces are not dirty on the printer or scanner.
- Make sure that the toner cartridge is full.
- Check the age of the toner cartridge.
- Make sure that the ink cartridge is full.
- Make sure that the wiper bar and the inside of the printer are clean.
- Check that the scanner arm is not taped or blocked in place.

Step 3: Try Quick Solutions First

After the obvious issues have been verified, try some quick solutions. Some quick solutions to printer and scanner problems include

- Restart the equipment.
- Cycle the power.
- Clear the jobs in the printer queue.
- Restart the printer spooler service.
- Remove and reinsert data cables.
- Shake the toner cartridge.
- Reinstall printer software.
- Reinsert paper.
- Remove tape from inkjet cartridge nozzles.

Step 4: Gather Data from the Computer

If quick solutions did not correct the problem, it is time to gather data from the computer. Some different ways to gather information about the printer and scanner problem include

- Printer settings
- Network settings
- Device Manager

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- Errors in queue
- User permissions
- Application print settings

Step 5: Evaluate the Problem and Implement the Solution

At this point, you will have enough information to evaluate the problem and research and implement possible solutions. Some resources for possible solutions include

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

Step 6: Close with the Customer

After you have solved the problem, you will close with the customer, which requires completing the following tasks:



Step 1. Discuss the solution implemented with the customer.

Step 2. Have the customer verify that the problem has been solved.

Step 3. Provide the customer with all paperwork.

Step 4. Document the steps taken to solve the problem in the work order and the technician's journal.

Step 5. Document any components used in the repair.

Step 6. Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Printer and scanner problems can be attributed to hardware, software, networks, or some combination of the three. You will resolve some types of problems more often than others. Table 14-3 provides a chart of common problems and solutions.

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Table 14-3 Common Problems and Solutions

Problem Symptom	Possible Solution
The printouts from a laser printer are faint and difficult to read. The toner cartridge is fresh and nearly full.	Restore print quality to normal setting.
An inkjet printer is filled with liquid ink.	Disconnect the power, clean the printer, and replace the cartridge. Avoid using refilled cartridges.
An inkjet printer is producing blotchy, streaked printouts.	Clean the print head with the cleaning utility.
The sensor arm on the scanner does not move.	Remove the tape or unlock the sensor arm.
Scanner produces copies with lines and marks.	Clean the glass and check for scratches.
An "out of memory" error is displayed when printing photographs.	Check the printer manual for RAM specifications, and then add RAM if possible.



Lab 14.6.3: Fix a Printer

In this lab, you will troubleshoot and fix a printer that does not print documents for a user. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.



Remote Technician 14.6.3: Fix a Printer Problem

In this Remote Technician Activity, you will gather data from the customer and then instruct the customer on how to fix a printer that does not print documents. You will then document the customer's problem in the work order provided in the activity. Refer to the Remote Technician Activity in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this activity now or wait until the end of the chapter.

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Summary

This chapter reviewed and discussed information about printers and scanners. The chapter explored hazards and safety procedures associated with printers and scanners. You have learned preventive maintenance methods, and you have installed, configured, and upgraded a printer or scanner, both locally and on a network. Here are some other important facts covered in this chapter:

- Always follow safety procedures when working with printers and scanners. There are many parts inside printers that contain high voltage or become very hot with use.
- Use the device manual and software to install a printer or scanner. After the installation, update the drivers and firmware to fix problems and increase functionality.
- Use the Windows interface to share printers and scanners across the network.
- Consult with the customers to determine how best to upgrade and configure printers and scanners to meet their needs.
- Keep printers, scanners, and supplies clean and dry. Keep supplies in their original packaging to prevent breakdowns and downtime. Develop a maintenance schedule to clean and check devices on a regular basis.
- Use a sequence of steps to fix a problem. Start with simple tasks before you decide on a course of action. Call a qualified or certified printer technician when a problem is too difficult for you to fix.

Summary of Exercises

This is a summary of the Labs, Worksheets, and Remote Technician exercises associated with this chapter.



Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Lab 14.2.4: Install an All-in-One Printer/Scanner

Lab 14.3.2: Share the All-in-One Printer/Scanner

Lab 14.4.2: Optimize Scanner Output

Lab 14.6.3: Fix a Printer

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Worksheets

The following worksheet covers material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6):



Worksheet 14.5.1: Search for Certified Printer Technician Jobs

Remote Technician Activity

The following activity covers material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6):

Remote Technician 14.6.3: Fix a Printer Problem

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Which of the following connectors are SCSI types? (Choose two.)
   a. Fast/wide: 68-pin connector
   b. Fast SCSI: 68-pin connector
   c. SCSI 1: 50-pin connector
   d. Wide SCSI: 50-pin connector
   e. Wide SCSI: 80-pin connector
2. What is the name given to the code that describes the layout and contents of a printed page?
   a. Page Layout Language
   b. Preview Description Language
   c. Page Description Language
   d. Page Preview Language
   e. Page Preview Description

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3. Which of the following functions are provided by a print server? (Choose two.)

   a. Drop damaged files.
   b. Provide client access to print resources.
   c. Automatically reformat print requests to reduce network bandwidth consumed.
   d. Provide feedback to the users.
   e. Automatically prioritize print jobs.

4. What is an advantage of using network print servers?

   a. Print servers offer specialized operating system support to PCs on the network.
   b. Print servers offer more functions than all-in-one devices.
   c. Print servers are always accessible because they are always powered on.
   d. Print servers keep a communication link to the computer that sent the print job until the document is printed.

5. Which of the following scanner options are used to improve document or image scans? (Choose two.)

   a. Resolution changes
   b. Output file format
   c. Printing capacity
   d. Source image size
   e. Input file format

6. When closing with a customer, which of the following actions are expected to be performed by a technician? (Choose three.)

   a. Evaluate the user efficiency in the troubleshooting process.
   b. Document any components used and the time spent to resolve the problem.
   c. Evaluate the information gathered from the user against the solution.
   d. Document steps taken to solve the problem in the work order.
   e. Educate the user by making the user follow the steps to repair the reported problem.
   f. Discuss the solution implemented.

7. Which of the following resources ensure that dedicated print servers can meet the demands of print clients? (Choose two.)

   a. Adequate storage space
   b. Adequate backup capacity
   c. Adequate RAM
   d. Wireless network support
   e. Firewall support

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8. How many peripherals can be attached to an IEEE 1394 port?

a. 24
b. 50
c. 63
d. 80
e. 127
f. 255

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CHAPTER 15

Advanced Networks

Objectives

Upon completion of this chapter, you will be able to answer the following questions:

- What are the potential safety hazards, and how do I implement proper safety procedures related to networks?
- How do I design a network based on the customer's needs?
- How do I determine the components for the customer's network?
- What does it take to implement the customer's network?
- How do I upgrade the customer's network?
- How do I install, configure, and manage a simple mail server?
- What are preventive maintenance procedures for a network?
- How do I troubleshoot the network?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

Secure Shell (SSH) *page xx*

Post Office Protocol (POP) *page xx*

Simple Mail Transfer Protocol (SMTP) *page xx*

plain old telephone service (POTS) *page xx*

digital subscriber line (DSL) *page xx*

Internet service provider (ISP) equipment *page xx*

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To meet the expectations and needs of your customers and network users, you must be familiar with networking technologies. You must understand the basics of how a network is designed and why some components affect the flow of data on a network.

This chapter focuses on advanced networking topics, including network design, network component upgrades, and e-mail server installations. Basic networking topics such as safety, network components, and preventive maintenance are also discussed. This chapter also describes troubleshooting advanced network situations.

Identify Potential Safety Hazards and Implement Proper Safety Procedures Related to Networks

Installing network cables, whether copper or fiber-optic, can be dangerous. Often, cables must be pulled through ceilings and walls where there are obstacles and unexpected or toxic materials. You should wear clothing that protects you from these materials. For example, wear long pants, a long-sleeved shirt, sturdy shoes that cover your feet, and gloves. Most importantly, wear safety glasses. If possible, ask building management, or someone responsible for the building, if there are any dangerous materials or obstacles that you need to be aware of before entering the ceiling area.

Be aware of these safety issues when using a ladder:

- Read the labels on the ladder, and follow any safety instructions written on it.
- Never stand on the top rung of the ladder. You could easily lose your balance and fall.
- Make sure that people in the area know you will be working there.
- Cordon off the area with caution tape or safety cones.
- When you are using a ladder that leans up against a wall, follow the instructions written on the ladder, and have someone hold the ladder to help keep it steady.

The tools required to install copper and fiber-optic cable may be dangerous to use. When working with cables, follow these rules:

- Make sure that the tools you are using are in good working order.
- Watch what you are doing, and take your time. Make sure that you do not cut yourself or place anyone in danger.
- Always wear safety glasses when cutting, stripping, or splicing cables of any kind. Tiny fragments can injure your eyes.
- Wear gloves whenever possible, and dispose of any waste properly.

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Use common sense when installing cables and fixing network problems. Call another person to help you if you need assistance.

After completing this section, you will meet these objectives:

- Explain fiber-optic safety.
- Explain cable, cable cutters, and cable-cutting safety hazards.

Explain Fiber-Optic Safety

Fiber-optic cables are useful for communications, but they have certain hazards:

- Dangerous chemicals
- Tools with sharp edges
- Light that you cannot see that can burn your eyes
- Glass shards produced by cutting fiber-optic cable that can cause bodily harm

Specific types of tools and chemicals are used when working with fiber-optic cable. These materials must be handled safely.

Chemicals

The solvents and glues used with fiber optics are dangerous. You should handle them with extreme care. Read any instructions, and follow them carefully. Also, read the material safety data sheet (MSDS) that accompanies the chemicals to know how to treat someone in an emergency.

Tools

When working with any tool, safety should always be your first priority. Any compromise in safety could result in serious injury or even death. The tools used for working with fiber optics have sharp cutting surfaces that are used to scribe glass. Other tools pinch cables with high pressure to fasten connectors to them. These tools can produce shards of glass that can splinter and fly into the air. You must avoid getting them on your skin and in your mouth or eyes.

Harmful Light

Protect your eyes from the harmful light that may be in the fiber-optic strands. The light is a color that humans cannot see. It can damage your eyes before you can feel it. When you use a magnifier to inspect fiber-optic cable and connectors, the light emitted from the fiber could be directed into your eyes. When working with fiber, be sure to disconnect the light source. Special detectors can tell you if a fiber is energized.

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Glass Shards

The process of cutting and trimming the strands of fiber-optic cables can produce tiny fragments of glass or plastic that can penetrate your eyes or skin and cause severe irritation. The fibers can be extremely difficult to see on your skin because they are clear and small. When you work with fiber-optic cabling, the working surface should be a dark mat so that you can see the tiny glass or plastic fragments. The mat should also be resistant to chemical spills.

You should keep the work area clean and neat. Never pick up fiber-optic fragments with your fingers. Use tape to pick up small fragments, and dispose of them properly. Use a disposable container, such as a plastic bottle with a screw-on lid, to store fiber fragments. Close the lid tightly before disposing of the container.

Caution

Obtain proper training before you attempt to cut, strip, or splice fiber-optic cable. An experienced technician should supervise you until you become adequately skilled.

Explain Cable, Cable Cutters, and Cable-Cutting Safety Hazards

All levels of technicians should know the hazards before working with network cables and equipment. This section describes the safety hazards of working with copper cables, which, like fiber-optic cables, can be dangerous to handle.

Caution

When handling cable, always wear eye protection. Never touch the ends of any type of cable to bare skin.

When you cut copper cable, the small copper strands can puncture your skin or cut you. The small pieces that come off after cables are cut often fly into the air. Remember to always wear safety glasses when cutting any type of cable.

The cutting and crimping tools used to repair or terminate copper cables can be dangerous if not used properly. Read the documentation that comes with the tool. Practice using the tool on scrap cable, and ask an experienced installer for help if you need it.

Remember that copper cable conducts electricity. An equipment fault, static electricity, or lightning can energize even a disconnected cable. If in doubt, test the cable you are working on with a simple voltage detector before touching it.

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Design a Network Based on the Customer's Needs

A network is most effective if it is designed to meet the customer's needs. Building a network requires analyzing the environment and understanding networking options. You should interview the customer, as well as any other people involved in the project. It is important to have a general idea about the hardware and software that will be used on the network. You should inquire about future growth of the company and the network.

After completing this section, you will meet these objectives:

- Determine a topology.
- Determine protocols and network applications.

Determine a Topology

You must understand the customer's needs and determine the general layout of the new network to properly determine the network topology. You need to discuss these important issues with the customer:

- Cable and wireless types
- Scalability
- Number and location of users

The number of users and the estimated amount of future growth determine the network's initial physical and logical topology. You should create a checklist to record the customer's needs.

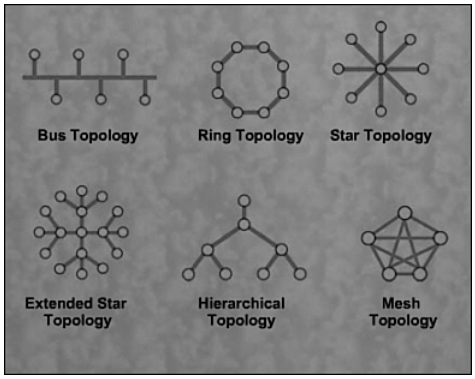
You should do an inspection, called a site survey, early in the project. A site survey is a physical inspection of the building that helps determine a basic logical topology, which is the flow of data and protocols. The number of users and the estimated amount of future growth determine the network's initial physical and logical topology. You should consider the following factors:

- Where the users' end-station computers will be.
- Where to position network equipment such as switches and routers.
- Where the servers will be positioned. This may be in the same room as the network equipment, or it could be elsewhere. The decision is often based on available space, power, security, and air conditioning.

A floor plan or blueprint is helpful to determine the physical layout of equipment and cables. Figure 15-1 shows a comparison of network topologies, including bus, ring, star, extended star, hierarchical, and mesh.

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Figure 15-1 Types of Topologies



If a floor plan or blueprint is not available, you should make a drawing of where the network devices will be located, including the location of the server room, the printers, the end stations, and cable runs. This drawing can be used for discussions when the customer makes the final layout decisions.

Determine Protocols and Network Applications

When designing a network, you must determine which protocols will be used. Some protocols are proprietary and work on only specific equipment, and others are open standards and work on a variety of equipment. Here are the details of the various network protocols:

- **Transmission Control Protocol/Internet Protocol (TCP/IP)** represents a set of public standards that specify how packets of information are exchanged between computers over one or more networks. The TCP/IP suite of protocols has become the dominant standard for internetworking.
- **Internetwork Packet Exchange/Sequenced Packet Exchange (IPX/SPX)** is the protocol suite employed originally by Novell Corporation's network operating system, NetWare. It delivers functions similar to those included in TCP/IP. Novell in its current releases supports the TCP/IP suite. A large installed base of NetWare networks continue to use IPX/SPX.
- **NetBIOS Extended User Interface (NetBEUI)** is a protocol used primarily on small Windows NT networks. NetBEUI cannot be routed or used by routers to talk to each other on a large network. NetBEUI is suitable for small peer-to-peer networks involving a few computers directly connected to each other. It can be used in conjunction with another routable protocol such as TCP/IP. This gives the network administrator the advantages of the high performance of NetBEUI within the local network and the capability to communicate beyond the LAN over TCP/IP.

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- **AppleTalk** is a protocol suite to network Macintosh computers. It consists of a comprehensive set of protocols that span the seven layers of the OSI reference model. The AppleTalk protocol was designed to run over LocalTalk, which is the Apple LAN physical topology. It is also designed to run over major LAN types, notably Ethernet and Token Ring.
- **Hypertext Transfer Protocol (HTTP)** governs how files such as text, graphics, sound, and video are exchanged on the World Wide Web (WWW). The Internet Engineering Task Force (IETF) developed the standards for HTTP.
- **File Transfer Protocol (FTP)** provides services for transferring files. FTP allows multiple simultaneous connections to remote file systems.
- ***Secure Shell (SSH)*** is used to securely connect to a remote computer.
- **Telnet** is an application used to connect to a remote computer, but it lacks security features.
- ***Post Office Protocol (POP)*** is used to download e-mail from a remote mail server.
- **Internet Message Access Protocol (IMAP)** is also used to download e-mail from a remote mail server.
- ***Simple Mail Transfer Protocol (SMTP)*** is used to send e-mail to a remote e-mail server.

Consider the following when selecting protocols:

- The TCP/IP suite of protocols is required for every device to connect to the Internet. This makes it a preferred protocol for networking.
- NetBEUI is a small, fast protocol that is useful in low-security networks. NetBEUI performs well in a small network that is not connected to the Internet. It is easy to install and requires no configuration. However, NetBEUI can cause unnecessary traffic on a large network, so it is not a good choice if the network will grow.
- IPX/SPX is a protocol that belongs to older versions of Novell Netware. Because of the growth of the Internet, newer versions of Novell Netware use TCP/IP instead of IPX/SPX.
- Apple Macintosh networks have abandoned the AppleTalk protocol for the TCP/IP suite of protocols to ensure connectivity with other TCP/IP networks, most notably the Internet.

When the TCP/IP protocol stack is enabled, other protocols become available on specific ports, as shown in Table 15-1.

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Table 15-1 Protocol Ports

Protocol	Port	Description
HTTP	Port 80	Transports web pages over a TCP/IP network
HTTPS	Port 443	Securely transports web pages over a TCP/IP network
SMTP	Port 25	Sends e-mail over a TCP/IP network
Telnet/SSH	Ports 23/22	Provides connections to computers over a TCP/IP network
FTP/TFTP	Port 20 or 21	Transports files over a TCP/IP network
DNS	Port 53	Translates URLs to IP addresses
DHCP	Port 67	Automates the assignment of IP addresses on a network



Worksheet 15.2.2: Protocols

In this worksheet, you identify the proper protocol to use in different network configurations. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this worksheet now or wait until the end of the chapter.

Determine the Components for the Customer's Network

The choice of network topology determines the type of devices, cables, and network interfaces that will be required to construct the network. In addition, an outside connection to an Internet service provider (ISP) must be set up. One of the steps in building a network is to determine suitable network components that work with user devices and the network cabling.

After completing this section, you will meet these objectives:

- Select cable types.
- Select the ISP connection type.
- Select network cards.
- Select the network device.

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Select Cable Types

Select the cable type that is the most beneficial and cost-effective for the users and services that will connect to the network.

The size of the network determines the type of network cable that will be used. Most networks today are wired using one or more types of twisted-pair copper cable:

- Category 5 (Cat5)
- Category 5e (Cat5e)
- Category 6 (Cat6)
- Category 6a (Cat6a)

Cat5 and Cat5e cables look the same, but Cat5e cable is manufactured with a higher standard to allow for higher data transfer rates. Cat6 cable is constructed with even higher standards than Cat5e. Cat6 cable may have a center divider to separate the pairs inside the cable.

The most common type of cable used in a network is Cat5e. Cat5e cable is an enhanced version of Cat 5 that adds specifications for far-end crosstalk. It was formally defined in 2001 in the TIA/EIA-568-B standard, which no longer recognizes the original Cat5. Cat5e is suitable for Fast Ethernet up to 330 feet (100 m).

Some businesses and homes have installed Cat6 cable so that they are prepared for additional bandwidth requirements in the future. Applications such as video, videoconferencing, and gaming use a large amount of bandwidth. Cat6 features more stringent specifications for crosstalk and system noise. The cable standard is suitable for 10BASE-T/100BASE-TX and 1000BASE-T (Gigabit Ethernet) connections. It provides performance of up to 250 MHz.

The most recent type of twisted-pair cable available is Cat6a. Cat6a cable carries Ethernet signals at a rate of 10 Gbps. The abbreviation for 10 Gigabit Ethernet over twisted-pair cable is 10GBase-T, as defined in the IEEE 802.3an-2006 standard. Customers who need high-bandwidth networks can benefit from installing cable that can support Gigabit Ethernet or 10 Gigabit Ethernet.

New or renovated office buildings often have some type of UTP cabling that connects every office to a central point called the main distribution facility (MDF). The distance limitation of UTP cabling used for data is 330 feet (100 m). Network devices that are farther away than this distance limitation need a repeater or hub to extend the connection to the MDF.

When designing a network and selecting cable types, you also need to consider cost, security, future needs, and wireless options.

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Cost

When designing a network, cost is a consideration. Installing cables is expensive, but after a one-time expense, a wired network normally is inexpensive to maintain. Most of the devices on a wired network cost much less than the devices on a wireless network.

Security

A wired network usually is more secure than a wireless network. The cables in a wired network usually are installed in walls and ceilings and therefore are not easily accessible. Wireless is easier to eavesdrop. The signals are available to anyone who has a receiver. Making a wireless network as secure as a wired network requires the use of encryption.

Design for the Future

Many organizations install the highest-grade cable available to ensure that their networks can handle the network speeds that will be available in the future. These organizations want to avoid expensive reinstallation of cable later. You and your customer must decide if the cost of installing a higher grade of cable is necessary.

Wireless

A wireless solution may be possible in places where cables cannot be installed. Consider an older, historic building where local building codes do not permit structural modifications. In this case, installing cable is not possible, so a wireless connection is the only solution.

Select the ISP Connection Type

The ISP that you choose can have a noticeable effect on network service. Some private resellers that connect to a phone company may sell more connections than allowed, which slows the overall speed of the service to customers.

An Internet connection has three main considerations:

- Speed
- Reliability
- Availability

This section describes ISP connection types and the advantages and disadvantages of each.

Plain Old Telephone Service (POTS)

A ***plain old telephone service (POTS)*** connection is extremely slow, but it is available wherever there is a telephone. The modem uses the telephone line to transmit and receive data.

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Integrated Services Digital Network (ISDN)

The Integrated Services Digital Network (ISDN) offers faster connection times and has faster speeds than dialup. It also allows multiple devices to share a single telephone line. ISDN is very reliable because it uses POTS lines. ISDN is available in most places where the telephone company supports digital signaling.

Digital Subscriber Line (DSL)

Digital subscriber line (DSL), like ISDN, allows multiple devices to share a single telephone line. DSL speeds generally are faster than ISDN. DSL allows the use of high-bandwidth applications and lets multiple users share the same connection to the Internet. In most cases, the copper wires already in your home or business can carry the signals needed for DSL communication.

DSL technology has some limitations. DSL service is not available everywhere. It works better and faster the closer the installation is to the telephone provider's central office (CO). Also, DSL is much faster when receiving data over the Internet than when sending it. In some cases, the lines that are in place to carry telephone signals do not technically qualify to carry DSL signals.

Cable

Cable Internet connection does not use telephone lines. Cable uses coaxial cable lines originally designed to carry cable television. Like DSL, cable offers high speeds and an "always-on" connection, which means that even when the connection is not in use, the connection to the Internet is still available. Many cable companies offer telephone service as well.

Because cable television reaches many homes, it is an alternative for people unable to receive DSL service. Theoretically, the bandwidth of cable is higher than DSL, but it can be affected by limitations of the cable provider. Most homes that have cable television have the option to install high-speed Internet service.

Satellite

For people who live in rural areas, broadband satellite Internet connections provide a high-speed connection that is always on. A satellite dish is used to transmit and receive signals to and from a satellite that relays these signals back to a service provider.

The cost of installation and the monthly service fees are much higher than those for DSL and cable subscribers. Heavy storm conditions can degrade the quality of the connection between the user and the satellite, or between the satellite and the provider, slowing down or even disconnecting the connection. In most cases, the service provider provides a dialup connection as a backup.

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Wireless

Many types of wireless Internet service are available. The same companies that offer cellular service may offer Internet service. PCMCIA and PCI cards are used to connect a computer to the Internet. This service is not available in all areas.

Service providers may offer wireless Internet service using microwave technology in limited areas. Signals are transmitted directly to an antenna on the roof of the house or building.

Research the connection types that the ISPs offer before selecting an ISP. Check the services available in your area. Compare connection speeds, reliability, and cost before committing to a service agreement.

Table 15-2 describes some of the protocol details.

Table 15-2 Protocol Details

Type	Advantages	Disadvantages	Speed
POTS	Very common	Very slow speeds	Maximum of 56 kbps
		Cannot receive phone calls while connected	
ISDN	Higher speeds than POTS	Still much slower than other broadband technologies	BRI: up to 128 kbps PRI: up to 2.048 Mbps
DSL	Low cost	Must be close to the carrier	256 kbps to 24 Mbps
Cable	Very high download speed	Slow upload speeds	384 kbps to 24 Mbps
Satellite	Available when DSL and cable are not	Significant time lag	9 kbps to 24 Mbps
		More expensive than other broadband technologies	
Wireless	Scalable to customer needs	Very expensive	Up to 450 Mbps
		Limited market availability	

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Worksheet 15.3.2: ISP Connection Types

In this worksheet, you identify the best ISP based on a given scenario. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this worksheet now or wait until the end of the chapter.

Select Network Cards

Every device on a network requires a network interface. Many types of network interfaces exist:

- Most network interfaces for desktop computers are either integrated into the motherboard or are an expansion card that fits into an expansion slot.
- Most laptop network interfaces are either integrated into the motherboard or fit into a PCI Card or PCI Express Bus expansion slot.
- USB network adapters plug into any available USB port and can be used with both desktops and laptops.

Before purchasing a NIC, you should research the speed, form factor, and capabilities that the card offers. Check the speed and capabilities of the hub or switch that will be connected to the computer.

Ethernet NICs may be backward-compatible:

- If you have a 10/100-Mbps NIC and a hub that is only 10-Mbps, the NIC operates at 10 Mbps.
- If you have a 10/100/1000-Mbps NIC and a switch that operates at only 100 Mbps, the NIC operates at 100 Mbps.

However, if you have a gigabit switch, you will most likely need to purchase a gigabit NIC to match speeds. If plans exist to upgrade the network to Gigabit Ethernet in the future, be sure to purchase NICs that can support the speed. Costs can vary greatly, so select NICs that match your customer's needs.

Wireless NICs are available in many formats with many capabilities. You should select wireless NICs based on the type of wireless network that is installed, as described in the following examples:

- 802.11b NICs can be used on 802.11g networks.
- 802.11b and 802.11g NICs can be used on 802.11n networks.
- 802.11a can be used only on a network that supports 802.11a.

Choose wireless cards that match your customer's needs. You should know what wireless equipment is in use and what will be installed on the network to ensure compatibility and usability. Figure 15-2 shows four types of wireless network interfaces.

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Figure 15-2 Wireless Network Interfaces



Select the Network Device

Several types of devices are available to connect components on a network, including hubs, switches, routers, and ***ISP equipment***. Select network devices to meet your customer's needs.

Hubs

A hub is used to share data between multiple devices on a section of the network. The hub may connect to another networking device such as a switch or router that connects to other sections of the network. The maximum speed of the network is determined by the speed of the hub.

Hubs are used less often today because of the effectiveness and low cost of switches. Hubs do not segment network traffic, so they decrease the amount of available bandwidth to any device. In addition, because a hub cannot filter data, a lot of unnecessary traffic constantly moves between all the devices connected to it.

One advantage of a hub is that it regenerates the data that passes through it. This means that a hub can also function as a repeater. A hub can extend the reach of a network because rebuilding the signal pulses overcomes the effects of distance.

Switches

In modern networks, switches have replaced hubs as the central point of connectivity. As with a hub, the speed of the switch determines the maximum speed of the network. However, switches filter and segment network traffic by sending data only to the device to which it is supposed to be sent. This provides higher dedicated bandwidth to each device on the network.

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Switches maintain a switching table. The switching table contains a list of all MAC addresses on the network and a list of which switch port can be used to reach a device with a given MAC address. The switching table records MAC addresses by inspecting the source MAC address of every incoming frame, as well as the port on which the frame arrives. The switch then creates a switching table that maps MAC addresses to outgoing ports. When a frame arrives that is destined for a particular MAC address, the switch uses the switching table to determine which port to use to reach the MAC address. The frame is forwarded from the port to the destination. When frames are sent from only one port to the destination, other ports are unaffected, and bandwidth on the entire network is unaffected.

Routers

Routers connect networks. On a corporate network, one router port connects to the WAN connection, and the other ports connect to the corporate LANs. The router becomes the gateway, or path to the outside, for the LAN. In a home network, the router connects the computers and network devices in the home to the Internet. In this case, the router is a home gateway. The wireless router, shown in Figure 15-3, serves as a firewall and provides wireless connectivity. When the home router provides multiple services, it may be called a multifunction device.

Figure 15-3 Home Networking Devices



ISP Equipment

When subscribing to an ISP, you should find out what type of equipment is available so that you can select the most appropriate device. Many ISPs offer a discount on equipment that is purchased at the time of installation.

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Some ISPs may rent equipment on a month-to-month basis. This may be more attractive because the ISP supports the equipment if it fails or if the technology needs to be changed or upgraded. Home users may select to purchase equipment from the ISP because eventually the initial cost of the equipment will be less than the cost of renting the equipment.

Implement the Customer's Network

Installing and implementing a network can be a complicated task. Even a small home network installation can become difficult and time-consuming. However, careful planning helps ensure an easier and faster installation.

Here is an installation checklist:

- ❑ All parts are in
- ❑ Installation is scheduled
- ❑ Backups are available
- ❑ Access to needed passwords
- ❑ Extra supplies are handy
- ❑ Install components
- ❑ Test components

During the installation, the existing network may experience some downtime. For example, building modifications and network cable installation can cause disruption. The project is not complete until all devices have been installed, configured, and tested.

After completing this section, you will meet these objectives:

- Install and test the customer's network.
- Configure the customer's Internet and network resources.

Install and Test the Customer's Network

After you have determined the location of all network devices, you are ready to install the network cables. In some new or newly renovated buildings, network cables may have been installed during construction to avoid the problem of installing cables in finished walls later. If there is no preinstalled cable, you have to install it or have it installed.

If you plan to install the cable yourself, you need time to prepare. All the necessary materials should be available at the site at the time of installation, as well as the cable layout plan.

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These steps outline the process of physically creating a network:

How To

Step 1. To install the cable in ceilings and behind walls, you perform a cable pull. One person pulls the cable, and the other feeds the cable through the walls. Be sure to label the ends of every cable. Follow a labeling scheme that is already in place, or follow the guidelines outlined in TIA/EIA 606-A.

Step 2. After the cables have been terminated on both ends, you should test them to make sure there are no shorts or interference.

Step 3. Make sure that network interfaces are properly installed in the desktops, laptops, and network printers. After the network interfaces have been installed, configure the client software and the IP address information on all the devices.

Step 4. Install switches and routers in a secured, centralized location. All the LAN connections terminate in this area. In a home network, you may need to install these devices in separate locations, or you may have only one device.

Step 5. Install an Ethernet patch cable from the wall connection to each network device. Check to see if you have a link light on all network interfaces. In a home network, make sure that each network device port that connects to a device is lit.

Step 6. When all devices are connected and all link lights are functioning, you should test the network for connectivity. Use the **ipconfig /all** command to view the IP configuration on each workstation. Use the **ping** command to test basic connectivity. You should be able to ping other computers on the network, including the default gateway and remote computers. After you have confirmed basic connectivity, you must configure and test network applications such as e-mail and an Internet browser.

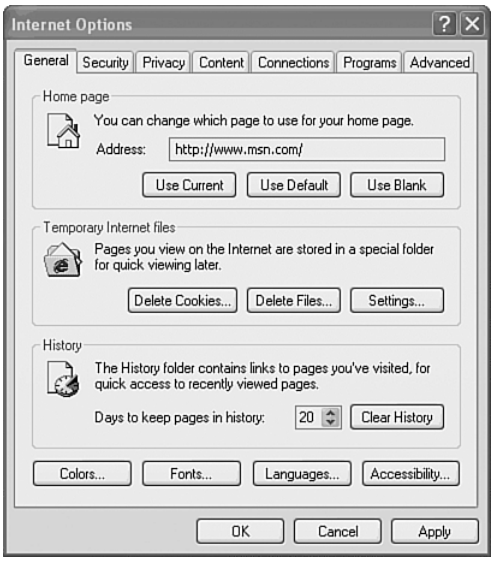
Configure the Customer's Internet and Network Resources

After the network has been set up and tested, you should configure a web browser, such as Microsoft Internet Explorer. You can configure browser settings and perform maintenance tasks in the Internet Properties dialog box, as shown in Figure 15-4.

Internet Explorer includes settings for temporary Internet files and the default browser. The customer may also need you to configure network resources such as file and printer sharing. The next sections describe these topics.

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Figure 15-4 Internet Explorer Options



Temporary Internet Files

When an operating system such as Windows XP has been installed, Internet Explorer is also installed by default. With Internet Explorer, every time you visit a website, many files are downloaded to your computer in the Temporary Internet Files folder. Most of these files are image files that represent banners and other components of the website.

Temporary Internet files are stored on your computer so that the browser can load content faster the next time you visit a website you have been to before. Depending on the number of websites you visit, the Temporary Internet Files folder can fill up quickly. Although this may not be an urgent problem, you should delete the files occasionally. This is especially important after you have done online banking or have entered other personal information into the web browser.

Default Browser

You can confirm which browser Windows uses by default. Choose **Start > Run**, enter a website address, and click **OK**. The website opens in the browser that is currently set as the default.

If you want Internet Explorer to be your default browser, start by opening Internet Explorer. On the toolbar, choose **Tools > Internet Options**. On the **Programs** tab, you can check to see if Internet Explorer is your default browser, and select it if desired.

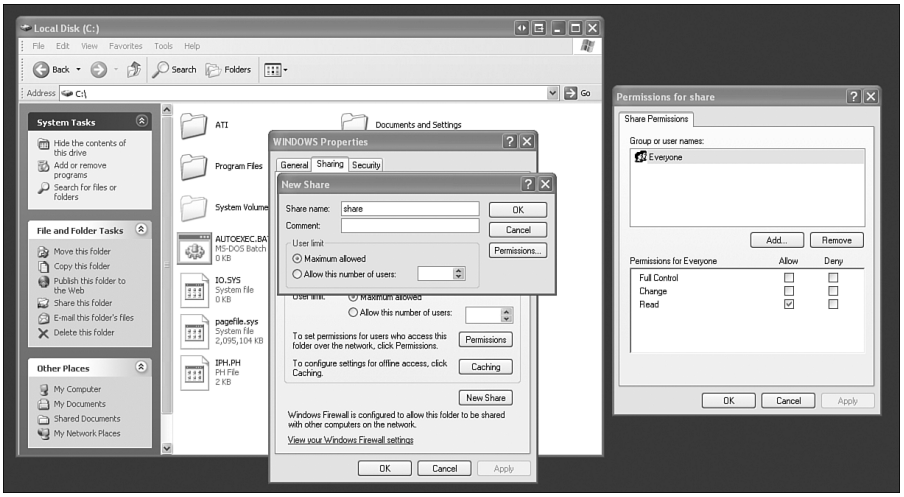
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File Sharing

Users can share resources over the network. You can share a single file, specific folders, or an entire drive.

To share a file, first copy it to a folder. Right-click the folder and select **Sharing and Security**. Next, select **Share this folder**. You can identify who has access to the folder and what permissions they have on the objects in the folder. Figure 15-5 shows the permissions window of a shared folder.

Figure 15-5 Share Folder Permissions



Permissions define the type of access a user has to a file or folder:

- **Read** allows the user to view the file and subfolder names, navigate to subfolders, view data in files, and run program files.
- **Change** has the same permissions as the Read permission and also allows the user to add files and subfolders, change the data in files, and delete subfolders and files.
- **Full Control** has the same permissions as Change and Read. If the file or folder is in an NTFS partition, Full Control allows you to change permissions on the file or folder and take ownership of the file or folder.

Windows XP Professional is limited to a maximum of ten simultaneous file-sharing connections.

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Printer Sharing

To share a printer, choose **Start > Control Panel > Printers and Faxes**. Right-click the printer icon and select **Sharing**. Click **Share this Printer**, and then click **OK**. The printer is now available for other computers to access.

To access a printer shared by another computer, choose **Start > Control Panel > Printers and Faxes**. Choose **File > Add Printer**. Use the **Add Printers** wizard to find and install the shared network printer.



Lab 15.4.2a: Configure Browser Settings

In this lab, you configure an Internet browser. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.



Lab 15.4.2b: Share a Folder, Share a Printer, and Set Share Permissions

In this lab, you share and configure a network folder and printer. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Upgrade the Customer's Network

You must be able to upgrade, install, and configure components when a customer asks for increased speed or new functionality to be added to a network. Devices such as wireless access points, wireless network cards, and faster network equipment and cable can be integrated into a network to allow the customer to communicate wirelessly or more quickly.

If your customer is adding computers or wireless functionality, you should be able to recommend equipment based on their needs. The equipment that you suggest must work with the existing equipment and cabling, or the existing infrastructure must be upgraded.

Network upgrades include

- Cable type
- Type of NIC
- Additional functionality (wireless, print server, and so on)

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After completing this section, you will meet these objectives:

- Install and configure a wireless NIC.
- Install and configure wireless routers.
- Test the connection.

Install and Configure a Wireless NIC

To connect to a wireless network, your computer must have a wireless network interface. A wireless network interface is used to communicate with other wireless devices, such as computers, printers, and wireless access points.

Before purchasing a wireless adapter, you should make sure that it is compatible with other wireless equipment that is already installed on the network. Also, verify that the wireless adapter is the correct form factor to fit in a desktop or laptop. A wireless USB adapter can be used with any desktop or laptop computer that has an open USB port.

To install a wireless NIC on a desktop computer, you must remove the case cover. Install the wireless NIC into an available PCI slot or PCI express slot. Some wireless NICs have an antenna connected to the back of the card. Some antennas are attached with a cable so that they can be moved around or away from objects that may cause a poor connection.

After the wireless adapter is installed, you must perform additional configuration steps. These include configuring device drivers and entering network address information. When this is complete, the computer should be able to detect and connect to the wireless LAN.

Wireless network adapters may use a wizard to connect to the wireless network. In this case, you would insert the CD that comes with the adapter and follow the directions to get connected.



Lab 15.5.1: Install a Wireless NIC

In this lab, you install a wireless NIC. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Install and Configure Wireless Routers

When installing a wireless network, you have to decide where you want to put access points, and then configure them. The following steps describe the installation of an access point:



Step 1. Use a floor plan to find locations for access points that allow maximum coverage. The best place for a wireless access point is at the center of the area you are covering, with a line of sight between the wireless devices and the access point.

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Step 2. Connect the access point to the existing network. On the back of the Linksys WRT300N router are five ports. Connect a DSL or cable modem to the port labeled "Internet." The device's switching logic forwards all the packets through this port when communication exists to and from the Internet and other connected computers. Connect one computer to any of the remaining ports to access the configuration web pages.

Step 3. Turn on the broadband modem, and plug the power cord into the router. When the modem finishes establishing a connection to the ISP, the router automatically communicates with the modem to receive network information from the ISP that is necessary to gain access to the Internet: IP address, subnet mask, and DNS server addresses.

Step 4. When the router has established communication with the modem, you must configure the router to communicate with the devices on the network. Turn on the computer that is connected to the router. Open a web browser. In the Address field, enter **192.168.1.1**. This is the default address for router configuration and management.

Step 5. A security window prompts you for authentication to access the router configuration screens. Leave the user name field empty. Enter **admin** as the default password. When you are logged in, the first setup screen appears.

Step 6. Continue with the setup. The setup screen has tabs that have subtabs. You must click **Save Settings** at the bottom of each screen after making any changes.

When you use the configuration screens of the 300N router, you can click the Help tab to see additional information about a tab. For information beyond what is shown on the help screen, consult the user manual.



Lab 15.5.2: Configure a Wireless Router

In this lab, you install a wireless router. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Test the Connection

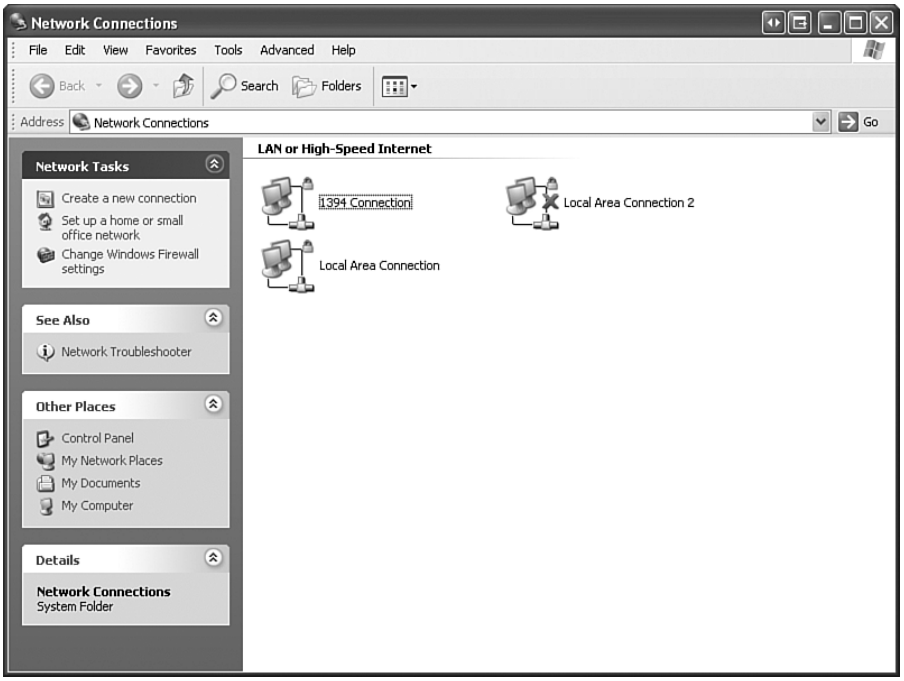
It may be difficult to know if your wireless connection is working properly, even when Windows indicates that you are connected. You may be connected to a wireless access point or home gateway, but you may not be connected to the Internet. The easiest way to test for an Internet connection is to open a web browser and see if the Internet is available. To troubleshoot a wireless connection, you can use the Windows GUI or CLI.

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Using the Windows XP GUI to Verify Network Connections

To verify a wireless connection using the Windows XP GUI, choose Start > Control Panel > Network Connections, as shown in Figure 15-6. Double-click the wireless network connection to display the status.

Figure 15-6 Network Connections



The Connection Status screen, shown in Figure 15-7, displays the number of packets that have been sent and received. The packets are the communication between the computer and the network device. The window shows whether the computer is connected, along with the connection's speed and duration.

To display the Address Type, as shown in Figure 15-8, choose the Support tab on the Connection Status screen. The Connection Status information includes either a static address, which is assigned manually, or a dynamic address, which is assigned by a DHCP server. The subnet mask and default gateway are also listed. To access the MAC address and other information about the IP address, click Details. If the connection is not functioning correctly, click Repair to reset the connection information and attempt to establish a new connection.

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Figure 15-7 Connection Status

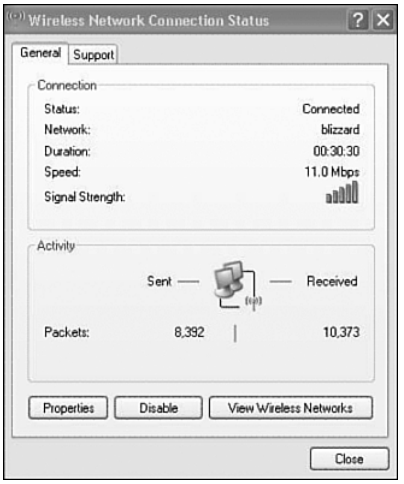


Figure 15-8 Address Type



Using the **ipconfig** Command to Verify Valid IP Addresses

The ipconfig command is a command-line tool that is used to verify that the connection has a valid IP address. The window displays basic IP address information for network connections. To perform specific tasks, add switches to the ipconfig command, as shown in Table 15-3.

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Table 15-3 **ipconfig** Command Switches

ipconfig Command Switch	Description
/all	Displays the full configuration of all network adapters
/release	Releases the IP address of a network adapter
/renew	Renews the IP address of a network adapter
/flushdns	Empties the cache that stores DNS information
/registerdns	Refreshes DHCP leases and reregisters the adapter with DNS
/displaydns	Shows DNS information in the cache

Using the **ping** Command to Test Connectivity Between Devices

The ping command is a CLI tool used to test connectivity between devices. You can test your own connection by pinging your computer. To test your computer, ping your NIC. Choose Start > Run and enter cmd. At the command prompt, enter ping localhost. This command tells you if your adapter is working properly.

Ping your default gateway to check if your WAN connection is working properly. You can find the address for the default gateway by using the ipconfig command.

To test the Internet connection and DNS, ping a popular website. Choose Start > Run and enter cmd. At the command prompt, enter ping destination name.

The response of the ping command displays the domain's IP address resolution. The response shows replies from the ping or shows that the request timed out because a problem occurred.

Using the **tracert** Command to Trace Packets

The **tracert** command is a CLI tool that traces the route that packets take from your computer to a destination address. Choose Start > Run and enter cmd. At the command prompt, enter tracert.

The first listing in the window for the tracert result is the default gateway. Each listing after that is the router that packets are traveling through to reach the destination. Tracert shows you where packets are stopping, indicating where the problem is occurring. If listings show problems after the default gateway, this might mean that the problems are with the ISP, the Internet, or the destination server.

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Lab 15.5.3: Test the Wireless NIC

In this lab, you test the connection of the wireless NIC. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

Describe the Installation, Configuration, and Management of a Simple Mail Server

An e-mail system uses e-mail client software on the users' devices, and e-mail server software on one or more e-mail servers. This section describes the protocols and servers that enable e-mail communication.

Understanding E-mail Protocols

Clients read e-mail from the e-mail server using one of two protocols:

- POP
- IMAP

Clients send e-mail to an e-mail server, and e-mail servers forward e-mail to each other, using SMTP.

You need to know how to configure a client computer to accept the correct incoming mail format, and also understand the process for setting up a mail server. You can configure the e-mail client software using connection wizards, as shown in Figure 15-9.

Figure 15-9 E-mail Protocols



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Table 15-4 lists the advantages and disadvantages of each e-mail protocol.

Table 15-4 E-mail Protocol Comparison

Protocol	Advantages	Disadvantages	Port	Sends Mail?	Retrieves Mail?
SMTP	Delivers e-mail from one server to another	Client upload only	25	Yes	No
	Can send mail directly to the destination				
POP	Simple	Download only	110	No	Yes
	Supports intermittent connections	Cannot manage the mail on the server			
IMAP	Simple	Requires more disk space and CPU resources	143	No	Yes
	More features than POP				
	Stores mail on the server				
	Faster than POP				
	Allows simultaneous access by multiple clients				

SMTP sends e-mail from an e-mail client to an e-mail server, or from one e-mail server to another. SMTP has these characteristics:

- Simple, text-based protocol
- Sent over TCP using port 25
- Must be implemented to send e-mail
- Message is sent after recipients are identified and verified

An e-mail client uses POP to download e-mail from an e-mail server. The most recent version of POP is POP3. POP3 usually uses port 110.

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POP3 supports end users who have intermittent connections, such as dialup. A POP3 user can connect, download e-mail from the server, delete the e-mail, and then disconnect.

IMAP is similar to POP3, but it has additional features. Like POP3, IMAP allows you to download e-mail from an e-mail server using an e-mail client. The difference is that IMAP allows the user to organize e-mail on the network e-mail server. IMAP is faster than POP3 and requires more disk space on the server and more CPU resources. The most recent version of IMAP is IMAP4. IMAP4 is often used in large networks such as a university campus. IMAP usually uses port 143.

Installing the E-mail Server

An e-mail server is a computer that can send and receive e-mail on behalf of e-mail clients. Common e-mail servers include the following:

- Microsoft Exchange
- Sendmail
- Eudora Internet Mail Server (EIMS)

As shown in Figure 15-10, wizards and tools often are available to guide you in setting up an e-mail server. To install and set up an e-mail server, such as Microsoft Exchange, you must first make sure that the network has all the proper qualifications in place and that it is properly configured. Be prepared with the proper equipment and information:

- Fully functional and reliable DNS deployment
- Active Directory domain
- At least one global catalog
- Windows 2000 or higher native domain functionality
- Exchange server software
- Windows server support tools
- Schema master server
- High-speed Internet connection

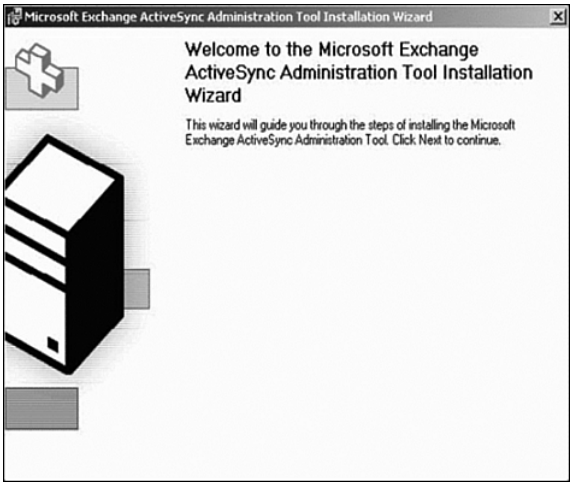
Note

Before planning an e-mail server installation, consult with network professionals, experienced Windows networking experts, or experienced e-mail technicians.

Active Directory servers, global catalog servers, and Domain Name System (DNS) servers must all be in place and functioning before Exchange can be installed and work properly. An Active Directory server is a computer that hosts a database that allows centralized administration over an enterprise network. A global catalog server is a centralized repository that contains information about every domain in an enterprise network.

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Figure 15-10 Exchange Server Installation Screen



The Active Directory database is organized in a pattern called a schema. One server running Windows 2003 is designated as the schema master. This is the only server that can change how the Active Directory user database is organized. When the network administrator needs to modify the Active Directory structure, the change is made on the schema master. Active Directory then automatically copies the update to the rest of the authentication servers.

You should test the environment before you install Exchange. To prevent the installation from affecting the daily operation of your network, set up the services required, and install Exchange on a dedicated set of servers away from the main network. Keep the installation of Exchange separate from your production network until you are sure that it is functioning properly.

You are ready to install the mail server when all the qualifications of your network are in place. You have to add Internet Information Services (IIS) using the Add/Remove Windows Components wizard before initiating the installation of the Exchange server. IIS is a server that has programs used to build and administer website services. After IIS has been installed, Exchange can be installed. Insert the installation CD and begin the New Exchange installation wizard.

The installation wizard takes you through a series of steps to verify that Exchange is ready to be installed. The wizard checks to make sure that IIS is installed, the domain servers are running properly, and the Windows support tools are installed. The setup program notifies you of any problems with the installation environment. Restart the setup program from the beginning after fixing any issues.

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Managing the E-mail Server

After Exchange is installed, the Microsoft Management Console plugin for Exchange provides access to many settings in one convenient location. Be sure to install all updates so that the server will run properly. The Exchange System Manager, which is a console that controls the Exchange deployment, can be used to manage the server's options.

Use the Active Directory Users and Computer (ADUC) console to configure a user's mailbox. This is also known as making the user "mailbox-enabled."

Open the ADUC to create a new user. Fill out the username and password information according to the domain security policy. The exchange server creates the user's mailbox when the user receives the first e-mail.

Setting up Exchange takes careful planning, including ensuring that the servers, services, and technologies are in place and working correctly on the network. In some cases, during an installation, if a failure occurs, you may need to reinstall the operating system and start the Exchange installation from the beginning.

Describe Preventive Maintenance Procedures for Networks

Preventive maintenance is just as important for the network as it is for the computers on a network. You must check the condition of cables, network devices, servers, and computers to make sure that they are kept clean and are in good working order. You should develop a plan to perform scheduled maintenance and cleaning at regular intervals. This helps you prevent network downtime and equipment failures.

As part of a regularly scheduled maintenance program, inspect all cabling for breaks. Make sure that cables are labeled correctly and labels are not coming off. Replace any worn or unreadable labels. Check that cable supports are properly installed and that no attachment points are coming loose. Cabling can become damaged and worn. You should keep the cabling in good repair to maintain good network performance.

As a technician, you may notice if equipment is failing, damaged, or making unusual sounds. Inform the network administrator to prevent unnecessary network downtime.

Cables at workstations and printers should be checked carefully. Cables are often moved or kicked when they are under desks, and they can be bent. These conditions can result in loss of bandwidth or connectivity. You should also be proactive in the education of network users. Demonstrate to network users how to properly connect and disconnect cables, as well as how to move them if necessary.

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Troubleshoot the Network

To begin troubleshooting a network problem, you should first try to locate the source of the problem. Check to see if a group of users or only one user has the problem. If the problem is with one user, begin troubleshooting the problem starting with that person's computer.

After completing this section, you will meet these objectives:

- Review the troubleshooting process.
- Identify common problems and solutions.
- Apply troubleshooting skills.

Review the Troubleshooting Process

Network problems can result from a combination of hardware, software, and connectivity issues. Computer technicians must be able to analyze the problem and determine the cause of the error to repair the network issue. This process is called troubleshooting.

Review the following troubleshooting process:



Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

The first step in the troubleshooting process is to gather data from the customer.

Ask the customer open-ended questions about network errors. (The following list is *not* comprehensive.)

- When did the problem start?
- What problems are you experiencing?
- Can you tell me anything else about the problem?
- What other users are having the problem?
- What type of equipment is having the problem?
- What are the effects of the problem?
- Describe your work environment.
- When did you last back up your computer?

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- What type of backup did you perform?
- What group are you a member of?

Ask the customer closed-ended questions about network errors. (The following list is *not* comprehensive.)

- Has any equipment changed?
- Have any peripherals been added?
- Have any other computers been added to the network?
- Have you rebooted the equipment?

After you talk to the customer, you should verify the obvious issues. Issues that apply to networks include the following:

- What is your IP information?
- Are the settings on the network equipment correct?
- Is there activity on the wireless router?
- Is there activity on the modem?
- Is your wireless client configured correctly?
- Has your network connection been disabled?

After you have verified the obvious issues, try the following quick solutions to network problems:

- Restart the equipment.
- Renew the IP address.
- Flush DNS.
- Roll back a driver.
- Return to the previous saved restore point.

If quick solutions do not correct the problem, it is time to gather data from the computer. Here are some different ways to gather information about the network problem:

- Open Device Manager.
- Open Event Viewer.
- Use **ipconfig**.
- Ping the localhost.
- Ping the local IP address.

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- Ping the default gateway.
- Ping a popular website.
- Verify wireless router configuration.
- Verify e-mail client configuration.

At this point, you have enough information to evaluate the problem and then research and implement possible solutions. When researching possible solutions for a problem, use the following resources:

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

After you have solved the problem, you close with the customer. Tasks required to complete this step include the following:

- Discuss the solution implemented with the customer.
- Have the customer verify that the problem has been solved.
- Provide the customer with all the paperwork.
- Document the steps taken to solve the problem in the work order and the technician's journal.
- Document any components used in the repair.
- Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Network problems can be attributed to hardware, software, networks, or some combination of the three. You will resolve some types of problems more often than others. Table 15-5 is a chart of common network problems and solutions.

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Table 15-5 Common Problems and Solutions

Problem Symptom	Possible Solution
Users report that a network printer is increasingly unreliable. The network cable travels under a desk and has become frayed and pinched.	Replace and reroute the network printer cable.
The user's Connection Status screen shows fewer than a dozen packets sent and received, even though the computer has been on for hours.	The wireless connection has failed. Reset the wireless adapter card, click Repair to refresh the IP address, and check again.
A user is making many changes in the configuration of a WRT300N wireless router, but the changes do not seem to remain in effect.	The user must click Save Settings at the bottom of each screen after making any changes.
A user receives a warning message that hard drive space is low.	Locate the folder where web browser or temporary files are stored, and verify that the folder size is a problem. Use Disk Cleanup or the browser cleanup utility to delete the temporary files, or delete them manually.
A network has become slow as more users are added. All users connect to a 24-port hub.	Replace the hub with a switch.

Apply Troubleshooting Skills

Now that you understand the troubleshooting process, it is time to apply your listening and diagnostic skills.

Lab 15.8.3 is designed to reinforce your skills with networks. You troubleshoot and fix a computer that does not connect to the network.

Remote Technician 15.8.3 is designed to reinforce your communication and troubleshooting skills. In this lab, you follow these steps:

- Receive the work order.
- Take the customer through various steps to try and resolve the problem.
- Document the problem and the resolution.

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Lab 15.8.3: Fix a Network Problem

In this lab, you correct a network problem. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.



Remote Technician 15.8.3: Fix a Network Problem

In this lab, you instruct a customer on how to correct a network problem. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition. You may perform this lab now or wait until the end of the chapter.

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Summary

This chapter has discussed the planning, implementation, and upgrading of networks and network components. The following are some of the important concepts to remember from this chapter:

- Many safety hazards are associated with network environments, devices, and media. You should follow proper safety procedures at all times.
- Networks must be designed with the customer in mind. Make design decisions that meet your customer's needs and goals.
- Select network components that offer the services and capabilities necessary to implement a network based on the customer's needs.
- Plan network installations based on the services and equipment necessary to provide the network that is needed.
- Upgrading a network may involve additional equipment, advanced equipment, or cabling. Discuss how upgrading can help enhance the network's usability in the future.
- Plan for an e-mail installation before deployment. Consult a specialist to make sure that the installation and configuration of an e-mail server go smoothly.
- Prevent network problems by developing and implementing a solid preventive maintenance policy.
- Follow a logical methodology to troubleshoot advanced network problems.

Summary of Exercises

This is a summary of the labs, worksheets, and remote technician exercises associated with this chapter.



Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Lab 15.4.2a: Configure Browser Settings

Lab 15.4.2b: Share a Folder, Share a Printer, and Set Share Permissions

Lab 15.5.1: Install a Wireless NIC

Lab 15.5.2: Configure a Wireless Router

Lab 15.5.3: Test the Wireless NIC

Lab 15.8.3: Fix a Network Problem

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Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Worksheet 15.2.2: Protocols

Worksheet 15.3.2: ISP Connection Types



Remote Technician Activity

The following activity covers material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition:

Remote Technician 15.8.3: Fix a Network Problem

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Which protocol is fast and useful on small networks with low security requirements?

   A. AppleTalk
   B. HTTP
   C. IPX/SPX
   D. NetBEUI

2. What is a hazard of working with copper cabling?

   A. Chemicals
   B. Copper strands
   C. Glass splinters
   D. Light

3. Which Internet technology offers a high-speed connection in rural areas but can be adversely affected by the weather?

   A. Cable
   B. DSL
   C. ISDN
   D. Satellite

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4. Which network device can regenerate the data signal without segmenting the network?

   A. Hub
   B. Modem
   C. Switch
   D. Router

5. A network technician has been asked to install cabling in a new building. Which important task must be completed as part of the installation?

   A. Label at least one end of every cable to identify the cable.
   B. Cordon off the area, and allow only two technicians in the area.
   C. Run all cabling, using only one person to avoid confusion.
   D. Label both ends of the cabling to identify each cable.

6. How do you access the wireless network connection using Windows XP?

   A. Choose **Start > Control Panel > Administrative Tools > Network Devices**.
   B. Choose **Start > Control Panel > Network Connections**.
   C. Choose **Start > Control Panel > Network Devices**.
   D. Choose **Start > Control Panel > Hardware > Network Connections**.

7. Which two protocols are used to receive e-mail?

   A. DHCP
   B. SNMP
   C. IMAP
   D. POP3
   E. SSH

8. A company purchases several wireless NICs at a great price. After installing the NICs, it finds that the users cannot connect to the wireless 802.11n network. What is a likely cause of the problem?

   A. The NICs are designed for the 802.11a standard.
   B. The NICs are designed for the 802.11b standard.
   C. The NICs are designed for the 802.11g standard.
   D. The NICs are designed for the 802.11n standard via USB.

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CHAPTER 16

Advanced Security

Objectives

Upon completion of this chapter, you should be able to answer the following questions:

- How do I outline security requirements based on customer needs?
- How can I select security components based on customer needs?
- What is the process to implement my customer's security plan?
- How do I perform preventive maintenance on security?
- What is the process to troubleshoot security?

Key Terms

This chapter uses the following key terms. You can find the definitions in the Glossary.

security policy *page xx*

physical security *page xx*

intrusion detection systems (IDS) *page xx*

hash encoding *page xx*

symmetric encryption *page xx*

asymmetric encryption *page xx*

Virtual Private Network (VPN) *page xx*

two-factor security *page xx*

data security *page xx*

smart card *page xx*

security key fob *page xx*

biometric device *page xx*

hardware firewall *page xx*

software firewall *page xx*

packet filter *page xx*

proxy firewall *page xx*

stateful packet inspection *page xx*

Wired Equivalent Privacy (WEP) *page xx*

Wi-Fi Protected Access (WPA) *page xx*

MAC address filtering *page xx*

service set identifier (SSID) broadcasting *page xx*

Windows XP Firewall *page xx*

zombie *page xx*

guest account *page xx*

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This chapter reviews the types of attacks that threaten the security of computers and the data contained on them. A technician is responsible for the security of data and computer equipment in an organization. The chapter describes how you can work with customers to ensure that the best possible protection is in place.

Risks to computers and network equipment come from both internal and external sources. Risks include physical threats, such as theft or damage to equipment, and data threats, such as the loss or corruption of data.

After completing this chapter, you will meet these objectives:

- Outline security requirements based on customer needs
- Select security components based on customer needs
- Implement a customer's security plan
- Perform preventive maintenance on security
- Troubleshoot security

Outline Security Requirements Based on Customer Needs

An organization should strive to achieve the best and most affordable security protection against data loss or damage to software and equipment. Network technicians and the organization's management should work together to develop a ***security policy*** to ensure that data and equipment have been protected against all security threats. A security policy includes a comprehensive statement about the level of security required and how this security will be achieved.

You might be involved in developing a security policy for a customer or organization. When creating a security policy, you should ask the following questions to determine security factors:

- **Is the computer located at a home or a business?** Home computers generally are more vulnerable to wireless intrusion than business computers. Business computers have a higher threat of network intrusion, because of users abusing their access privileges.
- **Is there full-time Internet access?** The more a computer is exposed to the Internet, the greater the chance of attacks from other infected computers. A computer accessing the Internet should include firewall and antivirus solutions.
- **Is the computer a laptop?** Physical security is an issue with laptop computers. There are measures to secure laptops, such as cable locks.

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After completing the following sections, you will meet these objectives:

- Outline a local security policy
- Explain when and how to use security hardware
- Explain when and how to use security application software

Figure 16-1 illustrates how the different approaches to security work together to ensure physical and data security.

Figure 16-1 Security Components



Outline a Local Security Policy

A security policy is a collection of rules, guidelines, and checklists. Network technicians and managers of an organization work together to develop the rules and guidelines for the security needs of computer equipment. A security policy includes the following elements:

- Defines an acceptable computer usage statement for an organization.
- Identifies the people permitted to use the computer equipment in an organization.
- Identifies devices that are permitted to be installed on a network, as well as the conditions of the installation. Modems and wireless access points are examples of hardware that could expose the network to attacks.
- Defines the requirements necessary for data to remain confidential on a network.
- Determines a process for employees to acquire access to equipment and data. This process can require the employee to sign an agreement regarding the company rules. It also lists the consequences for failure to comply.

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The security policy should also provide detailed information about the following issues in case of an emergency:

- Steps to take after a breach in security
- Who to contact in an emergency
- Information to share with customers, vendors, and the media
- Secondary locations to use in an evacuation
- Steps to take after an emergency is over, including the priority of services to be restored

Caution

A security policy must be enforced and followed by all employees to be effective.

Here is an example of an emergency checklist:

- **Data loss:**
  - Because of equipment theft
  - Because of wiretapping
  - Because of internal personnel
  - Because of external personnel
  - Because of temporary personnel/contractors/vendors
- **Power-related emergencies**:
  - Building or floor power outage
  - Local power outage
  - Large or regional power outage
- **Terrorist action**:
  - Terrorist attacks leading to evacuation
  - Terrorist attacks leading to lockdown
- **Theft**:
  - Physical theft of network device
  - Physical theft of desktop computer
  - Physical theft of laptop

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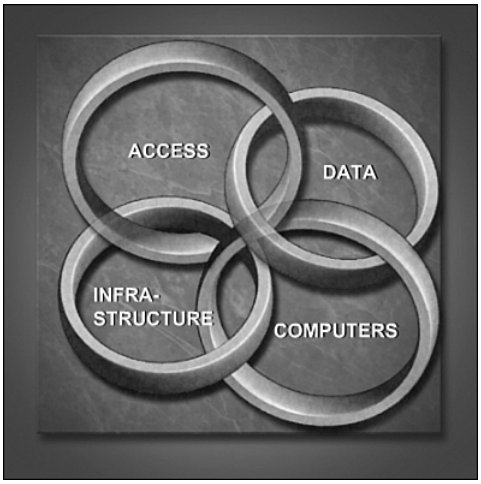
Worksheet 16.1.1: Answer Security Policy Questions

In this worksheet, you will answer security questions regarding the IT Essentials classroom. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can complete this worksheet now or wait to do so until the end of the chapter.

Explain When and How to Use Security Hardware

The security policy should identify hardware and equipment that can be used to prevent theft, vandalism, and data loss. There are four interrelated aspects to ***physical security***, which are access, data, infrastructure, and the computer, as illustrated in Figure 16-2.

Figure 16-2 Physical Security



Restrict access to premises with the following:

- Fences
- Security hardware

Protect the network infrastructure, such as cabling, telecommunication equipment, and network devices by implementing the following measures:

- Secured telecommunications rooms
- Wireless detection for unauthorized access points
- Hardware firewalls
- Network management system that detects changes in wiring and patch panels

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Protect individual computers by using the following:

- Cable locks
- Laptop docking station locks
- Lockable cases
- Secured cages surrounding desktop cases

Protect data with hardware that prevents unauthorized access or theft of media through the use of the following:

- Lockable hard drive carriers
- Secure storage and transport of backup media
- USB security dongles

Factors that determine the most effective security equipment to use to secure equipment and data include the following:

- How the equipment will be used
- Computer equipment location
- User-required access to data

For example, a computer in a busy public place, such as a library, requires additional protection from theft and vandalism. In a busy call center, a server might need to be secured in a locked equipment room.

Where it is necessary to use a laptop computer in a public place, a security dongle, shown in Figure 16-3, ensures that the system locks if the user and laptop are separated.

Figure 16-3 USB Security Dongle



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Explain When and How to Use Security Application Software

Security applications protect the operating system and software application data.

The following products and software applications can be used to protect network devices:

- **Software firewall**: Filters incoming data and is built into Windows XP
- ***Intrusion detection systems (IDS)***: Monitor and report on changes in program code and unusual network activity
- **Application and OS patches**: Update applications and the operating system to repair security weaknesses that are discovered

Several software applications are available to protect computers from unauthorized access by malicious computer code:

- Virus protection
- Spyware protection
- Adware protection
- Grayware protection

In small offices and homes, computers generally connect directly to the Internet rather than through a protected LAN that organizations use. This puts computers outside of a LAN at high risk for viruses and other attacks. At a minimum, these computers should use antivirus and antimalware protection programs. Application software and the operating system should be updated with the latest patches. A software firewall can also be part of the solution.

The security policy should determine the level of security applications put in place. Each step that increases protection costs money. In developing a policy, management should calculate the cost of data loss versus the expense of security protection and determine what trade-offs are acceptable.

Select Security Components Based on Customer Needs

The security policy helps customers to select the security components necessary to keep equipment and data safe. If there is no security policy, you should discuss security issues with the customer.

Use your past experience as a technician and research the current security products on the market when selecting security components for the customer. The goal is to provide the security system that best matches the customer's needs.

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After completing the following sections, you will meet these objectives:

- Describe and compare security techniques
- Describe and compare access control devices
- Describe and compare firewall types

Describe and Compare Security Techniques

A technician should determine the appropriate techniques to secure equipment and data for the customer. Depending on the situation, more than one technique might be required. The sections that follow describe the different techniques to secure equipment and data.

Passwords

Using secure, encrypted login information for computers with network access should be a minimum requirement in any organization. Malicious software monitors the network and can record plain-text passwords. If passwords are encrypted, attackers would have to decode the encryption to learn the passwords.

Tip

As covered in Chapter 9, "Fundamental Security," a strong password should contain a mixture of numbers, special characters, and uppercase and lowercase letters and have a minimum number of eight characters total.

Logging and Auditing

Event logging and auditing should be enabled to monitor activity on the network. The network administrator audits the log file of events to investigate network access by unauthorized users.

Wireless Configurations

Wireless connections are especially vulnerable to access by attackers. Wireless clients should be configured to encrypt data.

Encryption

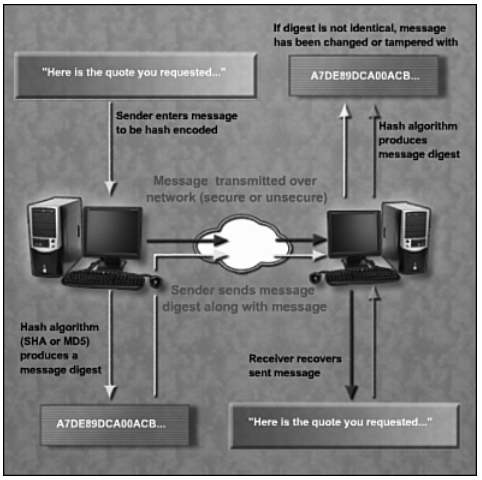
Encryption technologies are used to encode data being transmitted on a network.

Hash encoding, or hashing, ensures that messages are not corrupted or tampered with during transmission. Hashing uses a mathematical function to create a numeric value that is unique to the data. If even one character is changed, the function output, called the message digest, will not be the same. However, the function is one-way. Knowing the message digest does not allow an attacker to re-create the message. This makes it difficult for someone to

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intercept and change messages. Figure 16-4 illustrates the hash-encoding process. The names of the most popular hashing algorithms are SHA and MD5.

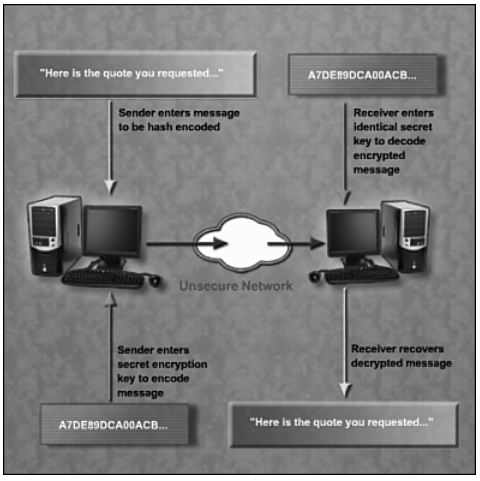
Figure 16-4 Hash Encoding



Symmetric Encryption

Symmetric encryption requires both sides of an encrypted conversation to use an encryption key to be able to encode and decode the data. The sender and receiver must use identical keys. Figure 16-5 illustrates the symmetric encryption process.

Figure 16-5 Symmetric Encryption

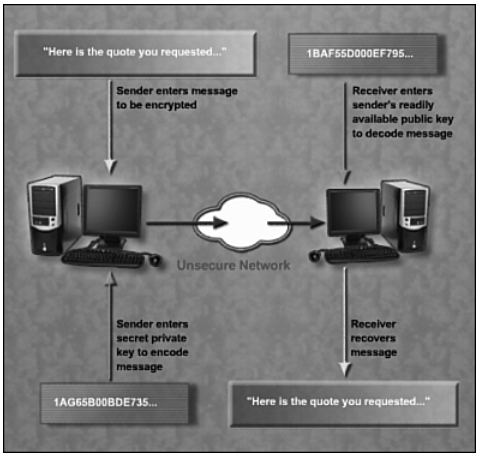


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Asymmetric Encryption

Asymmetric encryption requires two keys, a private key and a public key. A private key is required for writing a message, and a public key is needed to decode the message. The advantage of asymmetric encryption is that only the private key needs to be kept secret. Public keys can be distributed openly by e-mail or by posting them on the web. Figure 16-6 illustrates the asymmetric encryption process.

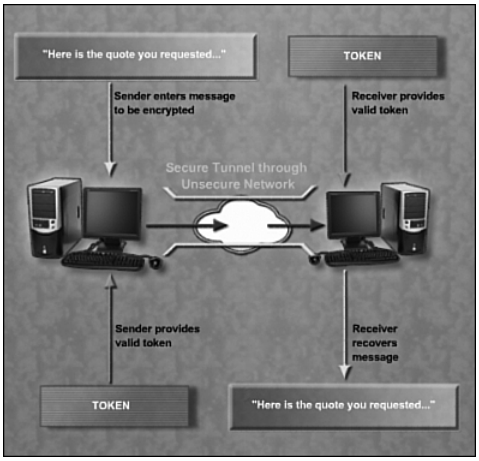
Figure 16-6 Asymmetric Encryption



Virtual Private Network

A ***Virtual Private Network (VPN)*** uses encryption to secure data as if it were traveling in a private, corporate LAN, even though the data actually travels over any network, for example, the Internet. The secured data pipelines between points in the VPN are called "secure tunnels." Figure 16-7 illustrates how a VPN is used to provide security.

Figure 16-7 Virtual Private Network



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Describe and Compare Access Control Devices

Computer equipment and data can be secured using overlapping protection techniques to prevent unauthorized access to sensitive data. An example of overlapping protection is using two different techniques to protect an asset. This is known as ***two-factor security***. When considering a security program, the cost of the implementation has to be balanced against the value of the data or equipment to be protected.

One example of a two-factor security technique is as follows:

> Password (good protection) + Biometrics or Smart Card (good protection) = Two-Factor Security (much better protection)

Physical Security

Use security hardware to help prevent security breaches and loss of data or equipment. Physical security access control measures include the following:

- **Lock**: The most common device for securing physical areas. If a key is lost, all identically keyed locks must be changed.
- **Conduit**: A casing that protects the infrastructure media from damage and unauthorized access.
- **Card key**: A tool used to secure physical areas. If a card key is lost or stolen, only the missing card must be deactivated. The card key system is more expensive than security locks.
- **Video equipment**: Records images and sound for monitoring activity. The recorded data must be monitored for problems.
- **Security guard**: Controls access to the entrance of a facility and monitors the activity inside the facility.

Network equipment should be mounted in secured areas. All cabling should be enclosed in conduits or routed inside walls to prevent unauthorized access or tampering. Network outlets that are not in use should be disabled. If network equipment is damaged or stolen, some network users can be denied service.

The security policy should specify the level of security required for the organization. Biometric devices, which measure physical information about a user, are ideal for use in highly secure areas. However, for most small organizations, this type of solution would be too expensive.

Data Security

You can protect data by using ***data security*** devices to authenticate employee access. Two-factor identification is a method to increase security. Employees must use both a password and a data security device similar to those listed here to access data:

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- ***Smart card***: A device that can store data safely. The internal memory is an embedded integrated circuit chip (ICC) that connects to a reader either directly or through a wireless connection. Smart cards are used in many applications worldwide, like secure ID badges, online authentication devices, and secure credit card payments.
- ***Security key fob***: A small device that resembles the ornament on a key ring. It has a small radio system that communicates with the computer over a short range. The fob is small enough so that many people attach them to their key rings. The computer must sense the signal from the key fob before it will accept a username and password.
- ***Biometric device***: Measures a physical characteristic of the user, such as fingerprints or the patterns of the iris in the eye. The user is granted access if these characteristics match its database and the correct login information is supplied.

The level of security that the customer needs determines which devices to select to keep data and equipment secure.

Describe and Compare Firewall Types

Hardware and software firewalls protect data and equipment on a network from unauthorized access. A firewall should be used in addition to security software.

A ***hardware firewall*** is a physical filtering component that inspects data packets from the network before they reach computers and other devices on a network. Hardware firewalls are often installed along with routers. A hardware firewall is a freestanding unit that does not use the resources of the computers it is protecting, so there is no impact on processing performance.

A ***software firewall*** is an application on a computer that inspects and filters data packets. Windows Firewall is an example of a software firewall that is included in the Windows operating system. A software firewall uses the resources of the computer, resulting in reduced performance for the user.

Consider the items listed in Table 16-1 when selecting a firewall.

Table 16-1 Hardware Versus Software Firewall

Hardware Firewall	Software Firewall
Freestanding and uses dedicated hardware.	Available as third-party software and cost varies.
Initial cost for hardware and software updates can be high.	Windows XP operating system provides software firewall.
Multiple computers can be protected.	Typically protects only the computer it is installed on.
Little impact on computer performance.	Uses the CPU, potentially slowing the computer.

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Hardware and software firewalls have several modes for filtering network data traffic:

- ***Packet filter***: A set of rules that allow or deny traffic based on criteria such as IP addresses, protocols, or ports used.
- ***Proxy firewall***: A firewall that inspects all traffic and allows or denies packets based on configured rules. A proxy acts as a gateway that protects computers inside the network.
- ***Stateful packet inspection***: A firewall that keeps track of the state of network connections traveling through the firewall. Packets that are not part of a known connection are not allowed back through the firewall.

Note

On a secure network, if computer performance is not an issue, you should enable the internal operating system firewall for additional security. Some applications might not operate properly unless the firewall is configured correctly for them.



Worksheet 16.2.3: Research Firewalls

In this worksheet, you will use the Internet, a newspaper, or a local store to gather information about hardware and software firewalls. Refer to the worksheet in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can complete this worksheet now or wait to do so until the end of the chapter.

Implement a Customer's Security Policy

Adding layers of security to a network can make the network more secure, but additional layers of security protection can be expensive. You must weigh the value of the data and equipment to be protected with the cost of protection when implementing the customer's security policy.

After completing the following sections, you will meet these objectives:

- Configure security settings
- Describe configuring firewall types
- Describe protection against malicious software

Configure Security Settings

Two common security errors are incorrect permissions on folders and files and incorrect configuration of wireless security. The sections that follow examine appropriate permission settings and wireless security configuration.

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Levels of Permission for Folders and Files

Permission levels are configured to limit individual or group user access to specific data. Both FAT and NTFS allow folder sharing and folder-level permissions for users with network access. NTFS folder permissions are categorized as follows:

- **Full Control**: This allows the user or group to change permissions of the folder, take ownership of it, and perform all activities included in all other permissions.
- **Modify**: Delete the folder plus perform actions permitted.
- **Read and Execute**: Move through folders to reach other files and folders, even if the users don't have permission for those folders, and perform actions permitted by the Read permission and List Folder Contents permission.
- **List Folder Contents**: See the names of the files and subfolders in the folder.
- **Read**: See files and subfolders in the folder and view folder ownership, permission, and attributes.
- **Write**: Create new files and subfolders within the folder, change folder attributes, and view folder ownership and permissions.

NTFS provides additional security of file-level permissions:

- **Full Control**: Change permissions and take ownership, plus perform the actions permitted by all other NTFS file permissions.
- **Modify**: Modify and delete the file, plus perform the actions permitted by the Write permission and Read and Execute permission.
- **Read and Execute**: Run applications, plus perform the actions permitted by the Read permission.
- **Read**: Read the file and view file attributes, ownership, and permissions.
- **Write**: Overwrite the file, change file attributes, and view file ownership and permissions.

Wireless Security Configuration

The following tools are used to configure wireless security:

- ***Wired Equivalent Privacy (WEP)***: Encrypts the broadcast data between the wireless access point and the client using a 64-bit or 128-bit encryption key.
- ***Wi-Fi Protected Access (WPA)***: Provides better encryption and authentication than WEP.
- ***MAC address filtering***: Restricts computer access to a wireless access point to prevent the casual user from accessing the network. MAC address filtering is vulnerable when used alone and should be combined with other security filtering.

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- ***Service set identifier (SSID) broadcasting***: The wireless SSID broadcasts the identity of the network. Turning off the SSID makes the network seem to disappear, but this is an unreliable form of wireless network security.
- **Wireless antennas**: The gain and signal pattern of the antenna connected to a wireless access point can influence where the signal can be received. Avoid transmitting signals outside of the network area by installing an antenna with a pattern that serves your network users.

Remember to do the following when configuring wireless security:

- Configure WEP.
- Configure WPA.
- Configure MAC address filtering.
- Disable any unused wireless connections.
- Change default SSID.
- Select appropriate antennas.

To improve the security of your wireless device, you should implement as many security options as possible. For example, this means combining things such as implementing WEP and changing the SSID to improve security.

Describe Configuring Firewall Types

A firewall selectively denies outside users from establishing connections to a computer or network segment. Firewalls generally work by opening and closing the ports that various applications use. By opening only the required ports on a firewall, you are implementing a restrictive security policy. Any packet not explicitly permitted is denied. In contrast, a permissive security policy permits access through all ports except those explicitly denied. At one time, software and hardware were shipped with all settings being permissive. As many users neglected to configure their equipment, the default permissive settings left many devices exposed to attackers. Most devices now ship with settings as restrictive as possible, while still allowing easy setup.

Software firewalls usually exist as a software application running on the computer being protected, or as part of the operating system. There are several third-party software firewalls. There is also a software firewall built into Windows XP, as shown in Figure 16-8.

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Figure 16-8 Windows XP Firewall



The configuration of the ***Windows XP Firewall*** can be completed in two ways:

- **Automatically**: The user is prompted to Keep Blocking, Unblock, or Ask Me Later for any unsolicited requests. These requests can be from legitimate applications that have not been configured previously or can be from a virus or worm that has infected the system.
- **Manage Security Settings**: The user manually adds the program or ports that are required for the applications in use on the network.

To add a program, choose **Start** > **Control Panel** > **Security Center** > **Windows Firewall** > **Exceptions** > **Add Program**.

To disable the firewall, choose **Start** > **Control Panel** > **Security Center** > **Windows Firewall**.



Lab 16.3.2: Configure Windows XP Firewall

In this lab, you will explore the Windows XP Firewall and configure some advanced settings. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.

Describe Protection Against Malicious Software

Malware is malicious software that is installed on a computer without the knowledge or permission of the user. Certain types of malware, such as spyware and phishing attacks, collect data about the user that can be used by an attacker to gain confidential information.

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You should run virus- and spyware-scanning programs to detect and clean unwanted software. Many browsers now come equipped with special tools and settings that prevent the operation of several forms of malicious software. It might take several different programs and multiple scans to completely remove all malicious software:

- **Virus protection**: Antivirus programs typically run automatically in the background and monitor for problems. When a virus is detected, the user is warned and the program attempts to quarantine or delete the virus.
- **Spyware protection**: Antispyware programs that scan for keyloggers and other malware so that it can be removed from the computer.
- **Adware protection**: Antiadware programs look for programs that display advertising on your computer.
- **Phishing protection**: Antiphishing programs block the IP addresses of known phishing websites and warn the user about suspicious websites.

A dangerous form of malicious software that incorporates elements of social engineering is the phishing attack. Figure 16-9 demonstrates a phishing attack website.

Figure 16-9 Phishing Attack Example



Note

Malicious software can become embedded in the operating system. Special removal tools are available from the operating system manufacturer to clean the operating system.

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Perform Preventive Maintenance on Security

Several maintenance tasks are necessary to ensure that security is effective. The following sections cover how to maximize protection by performing updates, backups, and reconfiguration of the operating systems, user accounts, and data.

After completing the following sections, you will meet these objectives:

- Describe the configuration of operation system updates
- Maintain accounts
- Explain data backup procedures, access to backups, and secure physical backup media

Describe the Configuration of Operating System Updates

An operating system is a likely target of attack because obtaining control of it can provide control of the computer. Then the compromised computer can be seized and put to work by the criminals. One popular use is to turn targeted computers into spam generators that launch attacking e-mails without the user being able to stop them. A computer compromised in this way is called a ***zombie***.

Windows XP automatically downloads and installs updates to operating systems by default. However, this might not be the best way to update systems. The updates might conflict with the security policy of an organization or might conflict with other settings on a computer. Furthermore, a network administrator might want to test the updates before the updates are distributed to all the network computers. The following Windows XP options give users the ability to control when software is updated:

- **Automatic**: Downloads and installs updates automatically without user intervention
- **Only download updates**: Downloads the updates automatically, but the user is required to install them
- **Notify me**: Notifies the user that updates are available and gives the option to download and install
- **Turn off automatic updates**: Prevents any checking for updates

If the user is on a dial-up network, the Windows Update setting should be configured to notify the user of available updates, or it should be turned off. The dialup user might want to control the update by selecting a time when the update does not interrupt other network activity or use the limited resources available.

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Maintain Accounts

Employees in an organization can require different levels of access to data. For example, a manager and an accountant might be the only employees in an organization with access to the payroll files.

Employees can be grouped by job requirements and given access to files according to group permissions. This process helps manage employee access to the network. Temporary accounts can be set up for employees that need short-term access. Close management of network access can help to limit areas of vulnerability that allow a virus or malicious software to enter the network.

Terminating Employee Access

When an employee leaves an organization, access to data and hardware on the network should be terminated immediately. If the former employee has stored files in a personal space on a server, eliminate access by disabling the account. At a later time, if the employee's replacement requires access to the applications and storage space, reenable the account and change its name to the name of the new employee.

Guest Accounts

Temporary employees and guests might need access to the network. For example, many visitors require access to e-mail, the Internet, and a printer on the network. These resources can all be made available to a special account called Guest. When guests are present, they can be assigned to the ***guest account***. When no guests are present, the account can be suspended until the next guest arrives.

Some guest accounts can require extensive access to resources, as in the case of a consultant or a financial auditor. This type of access should be granted only for the period of time required to complete the work.

Explain Data Backup Procedures, Access to Backups, and Secure Physical Backup Media

A data backup stores a copy of the information on a computer to removable backup media that can be kept in a safe place. If the computer hardware fails, the data backup can be restored so that processing can continue.

Data backups should be performed on a regular basis. The most current data backup is usually stored off-site to protect the backup media if anything happens to the main facility. Backup media is often reused to save on media costs. Always follow your organization's media rotation guidelines.

Backup operations can be performed at the command line or from a batch file using the **NTBACKUP** command. The default parameters for **NTBACKUP** will be the ones set in

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the Windows backup utility. Any options you want to override must be included at the command line. The **NTBACKUP** command cannot be used to restore files.

A combination of backup types, as shown in Table 16-2, allow the data to be backed up efficiently. A full or normal backup is a copy of all files on the drive. An incremental backup backs up only those files created or changed since the last normal or incremental backup. An archive bit marks files as having been backed up. A differential backup copies files created or changed since the last normal or incremental backup, but it does not mark files as having been backed up. Backing up data can take time, so it is preferable to do backups when the network traffic is low. Other types of backups include daily backup and copy backup, which do not mark the files as having been backed up.

Table 16-2 Backup Types

Type of Backup	Description
Full or Normal	Archives all selected files and resets the archive bit
Incremental	Archives all selected files that have changed since the last incremental backup
Differential	Archives all selected files that have changed since the last full backup
Daily	Archives all selected files that have changed on the day of the backup
Copy	Archives all selected files but does not reset the archive bit

The data backup media is just as important as the data on the computer. You should store the backup media in a climate-controlled off-site storage facility with adequate physical security. The backups should be readily available for access in case of an emergency.

Troubleshoot Security

The troubleshooting process is used to help resolve security issues. These problems range from simple, such as creating a backup, to more complex, such as a firewall configuration. Follow the steps outlined in the following sections to accurately identify, repair, and document the problem:



Step 1. Gather data from the customer.

Step 2. Verify the obvious issues.

Step 3. Try quick solutions first.

Step 4. Gather data from the computer.

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Step 5. Evaluate the problem and implement the solution.

Step 6. Close with the customer.

After completing the following sections, you will meet these objectives:

- Review the troubleshooting process
- Identify common problems and solutions
- Apply troubleshooting skills

Review the Troubleshooting Process

Computer technicians must be able to analyze a security threat and determine the appropriate method to protect assets and repair damage. This process is called *troubleshooting*.

Step 1: Gather Data from the Customer

The first step in the troubleshooting process is to gather data from the customer. Table 16-3 provides a list of open-ended and closed-ended questions to ask the customer about security threats. (This list is *not* comprehensive.)

Table 16-3 Security Threats: Open-Ended and Close-Ended Questions to Ask

Open-Ended Questions	Closed-Ended Questions
Are there any network resources that you can access by wireless?	Do you have a firewall?
When did the problem start?	Does your company have a security policy?
What problems are you experiencing?	Has anyone else used your computer?
What security software is installed on your computer?	Is your security software up to date?
How are you connected to the Internet?	Have you scanned your computer recently for viruses?
What type of firewall are you using?	Have you ever had any problems like this before?
Describe your work environment?	Have you changed your password recently?
When did you last back up your computer?	Have you received any error messages on your computer?
What type of backup was performed?	Have you shared your password?
What group are you a member of?	Do you back up your computer?
	Do you have permissions for the resource?

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Step 2: Verify the Obvious Issues

After you have talked to the customer, you should verify the obvious issues:

- Does the access point appear to be on?
- Does anyone else have this problem?
- Have you been able to connect to the Internet since the wireless router was upgraded?
- Does this problem occur only at your desk or at other areas of the office as well?
- Have you been able to connect through wireless at any other locations?
- Is the Automatic Updates feature turned on?
- Is the firewall configured properly?

Step 3: Try Quick Solutions First

After the obvious issues have been verified, try some quick solutions. Some quick solutions to laptop problems include

- Check the wireless signal strength at different locations in the area.
- Attempt to connect to the access point with security temporarily turned off to see whether a security setting is the problem.
- Log off and then back on.
- Reboot the device.
- Verify permissions on a resource.
- Run an antivirus scan or a spyware scan.

Step 4: Gather Data from the Computer

If quick solutions did not correct the problem, it is time to gather data from the computer. Some different ways to gather information about the problem from the laptop include

- Check firewall logs.
- Check Task Manager.
- Check dates on virus definitions.
- Check permissions.
- Check account type.
- Check with your system administrator.
- Verify that the Caps Lock and Num Lock keys are not on.

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Step 5: Evaluate the Problem and Implement the Solution

At this point, you will have enough information to evaluate the problem and research and implement possible solutions. Some resources for possible solutions include

- Problem-solving experience
- Other technicians
- Internet search
- Newsgroups
- Manufacturer FAQs
- Computer manuals
- Device manuals
- Online forums
- Technical websites

Step 6: Close with the Customer

After you have solved the problem, you will close with the customer. Closing with the customer usually includes the following:

- Discuss the solution implemented with the customer.
- Have customer verify that the problem has been solved.
- Provide the customer with all paperwork.
- Document steps taken to solved the problem in the work order and the technician's journal.
- Document any components used in the repair.
- Document the time spent to resolve the problem.

Identify Common Problems and Solutions

Security problems can be attributed to hardware, software, networks, or some combination of the three. You will resolve some types of security problems more often than others. Table 16-4 is a chart of common security problems and solutions.

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Table 16-4 Common Security Problems and Solutions

Problem Symptom	Possible Solution
A customer reports that a backup that was started the night before is still ongoing.	Advise the customer to implement a different type of backup that saves time.
A visiting consultant using a guest account cannot access needed files.	Grant access to the files for the duration of the visit. When the consultant leaves, disable the account.
A user refuses your request to e-mail you her student ID number and password.	Inform the user that there was no such request. Gather information and warn others against this phishing attack.
A user can locate a file on the server but cannot download it.	Change the user permissions on this file from Read to Read and Execute.
A user cannot connect to the network using a wireless router even after the proper security key has been installed.	Verify that the user's MAC address is listed in the MAC address filter table.



Lab 16.5.3: Fix a Security Problem

In this lab, you will gather data from the customer and then instruct the customer on how to correct a security issue that is preventing connection to the wireless network. Refer to the lab in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this lab now or wait until the end of the chapter.



Remote Technician 16.5.3: Fix a Security Problem

In this Remote Technician Activity, you will gather data from the customer to begin the troubleshooting process and document the customer's problem in the work order provided in the activity. Refer to the Remote Technician Activity in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6). You can perform this activity now or wait until the end of the chapter.

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Summary

This chapter discussed computer security and explained why it is important to protect computer equipment, networks, and data. Threats, procedures, and preventive maintenance relating to data and physical security were described to help you keep computer equipment and data safe. Security protects computers, network equipment, and data from loss and physical danger. The following are some of the important concepts to remember from this chapter:

- Security threats can come from inside or outside of an organization.
- Viruses and worms are common threats that attack data.
- Develop and maintain a security plan to protect both data and physical equipment from loss.
- Keep operating systems and applications up to date and secure with patches and service packs.

Follow these steps when setting up a security plan:



Step 1. Outline the customer's security requirements.

Step 2. Select security components.

Step 3. Implement a security plan.

Step 4. Perform preventive maintenance.

Step 5. Troubleshoot security.

Summary of Exercises

This is a summary of the Labs, Worksheets, and Remote Technician exercises associated with this chapter.



Labs

The following labs cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Lab 16.3.2: Configure Windows XP Firewall

Lab 16.5.3: Fix a Security Problem

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Worksheets

The following worksheets cover material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Worksheet 16.1.1: Answer Security Policy Questions

Worksheet 16.2.3: Research Firewalls



Remote Technician Activity

The following activity covers material from this chapter. Refer to the labs in *IT Essentials: PC Hardware and Software Labs and Study Guide*, Third Edition (ISBN 1-58713-198-6).

Remote Technician 16.5.3: Fix a Security Problem

Check Your Understanding

You can find the answers to these questions in the appendix, "Answers to Check Your Understanding Questions."

1. Which aspect of security includes biometrics and door locks?
   a. Securing access to data files
   b. Securing login access
   c. Securing wireless access
   d. Securing access to facilities
2. Which practice is a minimum requirement for securing a network?
   a. Deploy a firewall.
   b. Create secure login information for all users.
   c. Encrypt all data.
   d. Log all activity on the network.
3. Which item physically protects networking media from damage and unauthorized access?
   a. Conduit
   b. Hub
   c. Security guard
   d. Video equipment

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4. Which type of attack is launched by a hacker appearing to be a trusted organization and sending e-mail to trick the user into providing confidential information?

   a. Denial of service
   b. Grayware
   c. Phishing
   d. Trojan

5. Where should a technician begin gathering data when troubleshooting a computer problem?

   a. Operating system knowledge base
   b. Operating system logs
   c. User
   d. Vendor of the computer

6. A security consultant is trying to find a hardware device that will allow only authorized users to access confidential data. Which device will ensure that the data will be accessible by authorized employees only?

   a. Cable lock
   b. Docking station lock
   c. Lockable case
   d. Security dongle

7. On a Windows XP network, which task is necessary to ensure that any operating system vulnerabilities are removed and that identified errors are repaired?

   a. Audit both the system and user files on the computer system on a regular basis.
   b. Use a software-based firewall on a regular basis.
   c. Install a third-party spyware program to monitor traffic on a regular basis.
   d. Download and install operating system updates on a regular basis.

8. A technician notes that the corporate security policy is referred to as a restrictive security policy. Which definition describes a restrictive security policy?

   a. Any traffic not specifically denied is permitted.
   b. Only traffic entering the network through specific ports is permitted.
   c. Any traffic not specifically permitted is denied.
   d. Traffic is permitted only after it successfully passes all configured security measures.

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A

Appendix

Chapter 1

1. E
2. A
3. B
4. B
5. D
6. B
7. C
8. B

Chapter 2

1. C
2. B
3. A
4. C
5. B
6. B, F
7. B
8. C
9. A, B, D
10. C

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Chapter 3

1. C
2. D
3. D
4. B
5. B
6. A
7. D
8. D, E

Chapter 4

1. B, C, D
2. C, E
3. B
4. B
5. E

Chapter 5

1. A
2. C
3. B
4. E
5. C
6. A
7. E
8. A
9. B

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Chapter 6

1. A
2. B
3. B
4. D
5. B
6. A, D
7. C
8. D
9. D
10. B
11. C
12. B, C
13. B

Chapter 7

1. E
2. C
3. C, D, E
4. E
5. A
6. D
7. B
8. B

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Chapter 8

1. C
2. A
3. A
4. D
5. E
6. D
7. D
8. A
9. C
10. A

Chapter 9

1. A
2. D
3. D
4. B
5. C
6. A
7. A, D
8. D
9. B
10. A, D
11. C
12. B

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Chapter 10

1. B
2. B, C
3. C
4. B
5. D
6. A, B
7. B
8. B
9. C
10. C
11. A
12. C

Chapter 11

1. A, D, E
2. B
3. D, E
4. B, E, F
5. B
6. A, C
7. C
8. B
9. B, C
10. B
11. C, D

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Chapter 12

1. A
2. C, E
3. C
4. A
5. B
6. A
7. C

Chapter 13

1. F
2. D
3. D, E
4. D
5. E
6. A, C
7. A
8. B, F

Chapter 14

1. A, C
2. C
3. B, D
4. C
5. A, B
6. B, D, F
7. A, C
8. C

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Chapter 15

1. D
2. B
3. D
4. A
5. D
6. B
7. C, D
8. A

Chapter 16

1. A
2. D
3. D
4. B
5. C
6. A
7. A, D
8. D
9. B
10. A, D
11. C
12. B

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Glossary

This glossary defines many of the terms and abbreviations related to PC hardware and operating systems. It includes the key terms used throughout the book. As with any growing technical field, some terms evolve and take on several meanings. Where necessary, multiple definitions and abbreviation expansions are presented.

10BASE-T A 10-Mbps baseband Ethernet specification that uses two pairs of Category 3, 4, or 5 twisted-pair cabling. One pair of wires is used to receive data, and the other pair is used to transmit data. 10BASE-T, which is part of the IEEE 802.3 specification, has a distance limit of approximately 328 feet (100 m) per segment.

100BASE-TX A 100-Mbps baseband Fast Ethernet specification that uses two pairs of UTP or STP wiring. Based on the IEEE 802.3 standard.

100BASE-X A 100-Mbps baseband Fast Ethernet specification that refers to the 100BASE-FX and 100BASE-TX standards for Fast Ethernet over fiber-optic and copper cabling. Based on the IEEE 802.3 standard.

1000BASE-T A Gigabit Ethernet specification that uses UTP Category 5, 5e, or 6. Each network segment can have a maximum distance of 328 feet (100 m) without a repeater. Also known as 801.3ab.

A

Accelerated Graphics Port (AGP) A high-speed, 32-bit bus technology designed to support the acceleration of 3D computer graphics.

Access Control List (ACL) A list managed by a network administrator that itemizes what a user is permitted to access and the type of access granted. The network administrator uses ACLs to restrict packet access to the network.

access point A device that connects wireless devices to form a wireless network. An access point usually connects to a wired network, and it can relay data between wired and wireless devices. Connectivity distances can range from several feet or meters to several miles or kilometers.

AC power connector A socket that is used to connect the AC power adapter to a computer or docking station.

AC power cord A cable that transfers electricity from the AC power supply to the computer power supply.

active partition A partition on a hard disk drive that is set as the bootable partition. It usually contains the operating system to be used on the computer. Only one partition on a computer can be set as an active or bootable partition on a hard disk drive.

Active X An applet or small program created by Microsoft to control interactivity on web pages that has to be downloaded to gain access to the full functionality.

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adapter card An expansion card that increases the number of controllers and ports available on a computer.

Address Resolution Protocol (ARP) Discovers the local address (MAC address) of a station on the network when the IP address is known. End stations as well as routers use ARP to discover local addresses. The following switches are used with the **ARP** command:
-a displays the cache.
-d deletes an entry from the ARP cache.
-s adds a permanent IP-to-MAC address mapping.

administrator Someone who queries the User Registrar to analyze individual subscriber status and to gather data.

Advanced Configuration and Power Interface (ACPI) An interface that allows the operating system to control power management. Replaces Advanced Power Management (APM).

Advanced Power Management (APM) An interface that allows the BIOS to control the settings for power management. This has been replaced by the Advanced Configuration and Power Interface (ACPI).

Advanced Technology Extended (ATX) A standard computer case form factor for modern computers.

Advanced Technology Extended (ATX) power connector A 20-pin or 24-pin internal power supply connector.

adware A software program that displays advertising on a computer, usually distributed with downloaded software.

all-in-one type printer A multifunctional device designed to provide services such as printing, fax, and copier functions.

alternating current (AC) Current that changes direction at a uniformly repetitious rate. This type of electricity typically is provided by a utility company and is accessed by wall sockets.

American National Standards Institute (ANSI) A private, nonprofit organization that administers and coordinates the U.S. voluntary standardization and conformity assessment system. ANSI identifies industrial and public requirements for national consensus standards. It also coordinates and manages their development, resolves national standards problems, and ensures effective participation in international standardization.

American Standard Code for Information Interchange (ASCII) An 8-bit code for character representation (7 bits plus parity).

analog transmission Signal transmission over wires or through the air in which information is conveyed through the variation of some combination of signal amplitude, frequency, and phase.

answer file A file that contains predefined settings and answers to the questions that are required by the operating system setup wizard.

antistatic bag Packaging material that protects components from electrostatic discharge (ESD).

antistatic mat A surface that provides a safe environment for computer components by dissipating ESD.

antistatic wrist strap A device worn on the wrist to dissipate electrostatic discharge (ESD) between a person and electronic equipment.

antivirus application A program that is installed on a system to prevent computer viruses from infecting the computer.

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AppleTalk A protocol suite to network Macintosh computers. It is composed of a comprehensive set of protocols that span the seven layers of the OSI reference model.

application layer Layer 7 of the Open Systems Interconnection (OSI) reference model. This layer provides services to application processes such as e-mail, file transfer, and terminal emulation that are outside the OSI reference model. The application layer identifies and establishes the availability of intended communication partners and the resources required to connect with them. It also synchronizes cooperating applications and establishes agreement on procedures for error recovery and control of data integrity. It corresponds roughly with the transaction services layer in the Systems Network Architecture (SNA) model. The OSI reference model includes the application layer, presentation layer, session layer, transport layer, network layer, data link layer, and physical layer.

application software A program that performs a specific function by accepting input from the user and then manipulating it to achieve a result, known as the output.

arm (Acorn RISC Machine) architecture A low-power RISC CPU.

Asymmetric DSL (ADSL) Currently the most common DSL implementation. Speeds vary from 384 kbps to more than 6 Mbps downstream. The upstream speed typically is lower.

asymmetric encryption A method of encrypting data on a network. Uses a private key to write messages and a public key to decode the messages. Only the private key needs to be kept secret. Public keys can be distributed openly.

attention (AT) command set Issues dial, hang-up, reset, and other instructions to the modem. It is based on the Hayes command set.

attenuation The distance a signal can travel before it is too weak to be read.

Automatic Private IP Addressing (APIPA) An operating system feature that enables a computer to assign itself an address if it is unable to contact a DHCP server. The Internet Assigned Numbers Authority (IANA) has reserved private IP addresses in the range of 169.254.0.0 to 169.254.255.255 for APIPA.

Automatic Update A utility to schedule the Windows Update feature to check for critical updates.

auxiliary (AUX) power connector A four-, six-, or eight-pin connector that supplies extra voltage to the motherboard from the power supply.

B

backplane A physical connection between an interface processor or card, the data buses, and the power distribution buses inside a chassis.

backup A copy of data saved to alternate media. Should be physically removed from the source data.

backward-compatible Hardware or software systems that can use interfaces and data from earlier versions of the system or with other systems.

bandwidth The amount of data that can be transmitted within a fixed amount of time.

base station A device that attaches a laptop to AC power and to desktop peripherals.

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Basic Input/Output System (BIOS) A program stored in a ROM chip in the computer that provides the basic code to control the computer's hardware and to perform diagnostics on it. The BIOS prepares the computer to load the operating system.

Basic Rate Interface (BRI) An ISDN interface composed of two B channels and one D channel for circuit-switched communication of voice, video, and data. Compare with PRI.

battery An electrical device that converts chemical energy into electrical energy.

battery latch A tool used to insert, remove, and secure the laptop battery.

battery status indicator LED A light that indicates the condition of the laptop battery.

beep code An audible reporting system for errors that are found by the BIOS during the POST, represented by a series of beeps.

Berg power connector A keyed connector that supplies power to a floppy drive.

biometric device A tool that uses sensors, such as a fingerprint or retinal scanner, that identify the user's physical characteristics to allow access to a device or a network.

bit The smallest unit of data in a computer. A bit can take the value of either 1 or 0. A bit is the binary format in which data is processed by computers.

bit rate The speed at which bits are transmitted, usually expressed in bits per second (bps).

blackout A complete loss of AC power.

Bluetooth A wireless industry standard that uses an unlicensed radio frequency for short-range communication, enabling portable devices to communicate over short distances.

boot To start a computer.

bootable disk A troubleshooting tool that allows the computer to boot from a disk when the hard drive will not boot.

boot record A 512-byte file containing a table that describes the partition, the number of bytes per sector, and the number of sectors per cluster.

Border Gateway Protocol (BGP) Used to exchange routing information between autonomous systems on the Internet.

broadband Multiple signals using multiple frequencies over one cable.

broadband optical telepoint Infrared broadband transmission that can handle high-quality multimedia requirements.

broadband satellite A network connection using a satellite dish.

brownout A temporary drop in AC power.

buffer A storage area used to handle data in transit. Buffers are used in internetworking to compensate for differences in processing speed between network devices. Bursts of data can be stored in buffers until they can be handled by slower processing devices. Sometimes called a packet buffer.

bus A medium through which data is transferred from one part of a computer to another. The bus can be compared to a highway on which data travels within a computer.

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bus topology A network in which each computer connects on a common cable.

byte A unit of measure that describes the size of a data file, the amount of space on a disk or other storage medium, or the amount of data being sent over a network. One byte consists of 8 bits of data.

C

cable A set of conductors, bundled and sheathed, made of insulated copper or optical fiber, that transport signals and power between electrical devices.

cable modem Acts like a LAN interface by connecting a computer to the Internet. The cable modem connects a computer to the cable company network through the same coaxial cabling that feeds cable TV (CATV) signals to a television set.

cable tie A fastener used to bundle cables inside and outside a computer.

cache A data storage area that provides high-speed access for the system.

Caps Lock indicator LED A light that shows the on/off status of the Caps Lock.

card key An identity card with a chip that stores user data, including the level of access.

Category 3 A cable that is primarily used in telephone connections.

Category 5 A cable that contains four pairs of wires, with a maximum data rate of 1 Gbps.

Category 5e A cable that provides more twists per foot than Category 5 at the same data rate of 1 Gbps.

Category 6 A cable that is enhanced with more twists than Category 5e cable. It contains a plastic divider that separates the pairs of wires to prevent crosstalk. It is capable of 10 Gbps.

C: drive Generally the label for the first hard drive in a computer system. Drive A and Drive B are reserved for floppy drives. Drive B is rarely used on current computers.

cellular WAN A wide-area network that has the technology for the use of a cell phone or laptop for voice and data communications.

central processing unit (CPU) Interprets and processes software instructions and data. Located on the motherboard, the CPU is a chip contained on a single integrated circuit called the microprocessor. The CPU contains two basic components, a control unit and an Arithmetic/Logic Unit (ALU).

chip A small slice of silicon or germanium processed to have electrical characteristics so that it can be developed into an electronic component. Also called a semiconductor.

chip set Chips on a motherboard that enable the CPU to communicate and interact with the computer's other components.

CHKDSK A command used to check the integrity of files and folders on a hard drive by scanning the disk surface for physical errors.

client/server network A network in which services are located in a dedicated computer that responds to client (user) requests.

cluster The smallest unit of space used to store data on a disk. Also called the file allocation unit.

CMOS battery A battery that supplies power to maintain basic configuration information, including the real-time clock, when the computer is turned off.

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CMYK Display colors: cyan, magenta, yellow, and black.

coaxial cable Copper-cored cable surrounded by a heavy shielding. Used to connect computers in a network.

cold boot To power up a computer from the off position.

color ink jet printer A type of printer that uses liquid-ink-filled cartridges that spray ink to form an image on the paper.

command-line interface (CLI) An interface, such as a DOS prompt, that requires commands to be entered manually on the command line.

compact disc (CD) drive An optical device that reads compact discs.

compact disc read-only memory (CD-ROM) An optical storage medium for audio and data.

compact disc recordable (CD-R) An optical medium that allows data to be recorded but not modified.

compact disc rewritable (CD-RW) An optical storage medium that allows data to be recorded and modified.

Complementary Metal Oxide Semiconductor (CMOS) A type of semiconductor, or low-power memory firmware, that stores basic configuration information.

Complex Instruction Set Computer (CISC) An architecture that uses a broad set of instructions, with several choices for almost every operation. The result is that a programmer can execute precisely the command needed, resulting in fewer instructions per operation.

compressed air Air under pressure in a can that blows dust off of computer components without creating static. Also called canned air.

computer An electrical machine that can execute a list of instructions and perform calculations based on those instructions.

computer-aided design (CAD) An application used to create architectural, electrical, and mechanical design. More complex forms of CAD include solid modeling and parametric modeling, which allow objects to be created with real-world characteristics.

computer network Two or more computers connected by a medium to share data and resources.

computer system A combination of hardware and software components. Hardware is the physical equipment such as the case, floppy disk drives, keyboards, monitors, cables, speakers, and printers. Software describes the programs that operate the computer system.

conduit A casing that protects the infrastructure media from damage and unauthorized access.

configuration tool A service management tool or element management service tool with a GUI.

connector A device used to terminate cable.

conventional memory All memory addresses from 0 to 640 KB.

cookie A small text file that is stored on the hard disk that allows a website to track the user's association to that site.

copy backup Backs up user-selected files to tape. This backup does not reset the archive bit.

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crosstalk Interfering energy, such as electromagnetic interference (EMI), that is transferred from one circuit to another.

current (I) The flow of electrons in a conductor that is measured in amperes.

customer-replaceable unit (CRU) A component that customers may install at their location.

cylinder All the tracks on a hard disk with the same number. Collectively, the same track on all platters of a multiplatter hard drive.

D

daily backup Backs up only the files that are modified on the day of the backup. This backup does not reset the archive bit.

data backup Information on a computer stored on removable backup media that can be kept in a safe place. If the computer hardware fails, the data backup can be restored so that processing can continue.

database An organized collection of data that can be easily accessed, managed, indexed, searched, and updated.

data link layer Layer 2 of the Open Systems Interconnection (OSI) reference model. This layer provides reliable transit of data across a physical link. The data link layer is concerned with physical addressing, network topology, line discipline, error notification, ordered delivery of frames, and flow control. The IEEE has divided this layer into two sublayers—the MAC sublayer and the LLC sublayer, sometimes simply called link layer. Roughly corresponds to the data link control layer of the Systems Network Architecture (SNA) model. The OSI reference model includes the application layer, presentation layer, session layer, transport layer, network layer, data link layer, and physical layer.

data transfer rate Refers to how fast the computer can transfer information into memory.

default gateway A node or router on a network that provides access to another network or the Internet.

default installation An installation that requires minimal user interaction. Also called a typical installation.

default printer The first option that an application uses when the user clicks the printer icon. The user can change the default printer.

DEFRAG A command that rearranges the data and rewrites all the files on the hard drive to the beginning of the drive. This makes it easier and faster for the hard drive to retrieve data.

denial of service (DoS) A form of attack that prevents users from accessing normal services, such as e-mail or a web server, because the system is busy responding to an abnormally large number of requests. DoS works by sending an abundance of requests for a resource. This causes the system to overload and stop operating.

desktop A metaphor used to portray file systems. A desktop consists of pictures, called icons, that show files, folders, and any resource available to a user in a GUI operating system.

desktop computer A type of computer designed to fit on top of or under a desk. Desktop computers are not mobile like laptop computers.

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Device Manager An application that displays a list of all the hardware that is installed on the system.

diagnostic software Programs that assist in the troubleshooting process.

diagnostic tools Utilities that monitor the network server.

dialup networking (DUN) Using the public telephone system or network to communicate.

differential backup Backs up all the files that have been created or modified since the last full backup. It does not reset the archive bit.

digital audio tape (DAT) A tape standard that uses 4-mm digital audiotapes to store data in the digital data storage (DDS) format.

digital linear tape (DLT) Technology that offers high capacity and relatively high-speed tape backup capabilities.

digital multimeter (DMM) A tool that combines the functionality of a voltmeter, ohmmeter, and ammeter into one easy measuring device.

digital subscriber line (DSL) A public network technology that delivers high bandwidth over conventional copper wiring at limited distances. Always-on technology that allows users to connect to the Internet.

digital versatile disc (DVD) A removable medium that is used primarily for movie and data storage.

Digital Visual Interface (DVI) An interface that supplies uncompressed digital video to a digital monitor.

direct current (DC) Current flowing in one direction, as used in a battery.

direct memory access (DMA) A method of bypassing the CPU when transferring data from the main memory directly to a device.

directory 1) A type of file that organizes other files in a hierarchical structure. 2) Related program and data files organized and grouped in the DOS file system. 3) A place to store data in the Windows file-management system.

disk cleanup Disk-management software that is used to clear space on a hard drive by searching for files that can be safely deleted, such as temporary Internet files.

disk management A system utility used to manage hard drives and partitions, such as initializing disks, creating partitions, and formatting partitions.

disk operating system (DOS) A collection of programs and commands that control overall computer operations in a disk-based system.

display A computer output surface and projecting mechanism that shows text and graphic images.

DNS poisoning Changing the DNS records on a system to point to false servers where the data is recorded.

docking connector A socket used to attach a docking station to the laptop.

docking station A device that attaches a laptop to AC power and desktop peripherals.

domain A logical group of computers and electronic devices with a common set of rules and procedures administered as a unit.

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Domain Name System (DNS) A system that provides a way to map friendly hostnames, or URLs, to IP addresses.

dot-matrix printer A printer that operates by impacting the ribbon to place an image on the paper.

dots per inch (dpi) A measurement of print quality on a dot-matrix printer. The higher the dpi, the higher the print's quality.

drive bay A standard-sized area for adding hardware to a computer case. The two most common drive bays are used to house a CD/DVD drive and a floppy drive.

drive letter A designation that distinguishes the physical or logical drives in Windows.

drive mapping The process of assigning a letter to a physical or logical drive.

dual-core CPU Two cores inside a single CPU chip. The cores can be used together to increase speed, or they can be used in two locations at the same time.

dual inline memory module (DIMM) A circuit board with a 64-bit data bus that holds memory chips. A memory module with 168 pins. Supports 64-bit data transfers.

dual ring All the devices on the network connect to two cables, and the data travels in both directions. Only one cable is used at a time. If one ring fails, data is transmitted on the other ring.

DVD drive An optical device that reads DVDs. A DVD-rewritable (DVD-RW) drive can write to DVD-RWs.

DVD-R A DVD recordable format.

DVD+R A DVD that is a once-writable optical disc with 4.7 GB of storage.

DVD-ROM A DVD format that is designed to store computer files.

DVD-RW Technology that allows the medium to be recorded multiple times.

DVD+RW The name of a standard for optical discs. It is one of several types of DVD that hold up to 4.7 GB.

DVD-Video A DVD format that is used by standalone DVD players for movies and extras.

dye-sublimation printer A printer that uses solid sheets of ink that change from solid to gas in a process called sublimating. The gas then passes through the paper, where it turns back to a solid. The print head passes over a sheet of cyan, magenta, yellow, and a clear overcoat (CMYO). Also called a thermal dye printer.

Dynamic Host Configuration Protocol (DHCP) A software utility that automatically assigns IP addresses to client devices in a large network.

dynamic RAM (DRAM) RAM that stores information in capacitors that must be periodically refreshed. Delays can occur because DRAMs are inaccessible to the processor when refreshing their contents. However, DRAMs are less complex and have greater capacity than SRAMs.

dynamic routing Routing that adjusts automatically to network topology or traffic changes. Also called adaptive routing.

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E

eject button The lever that releases an object, such as the button on a floppy drive.

Electronic Industries Association (EIA) A group that specifies electrical transmission standards. The EIA and the Telecommunications Industry Association (TIA) have developed numerous well-known communications standards, including EIA/TIA-232 and EIA/TIA-449.

electronic mail (e-mail) Users' ability to communicate over a computer network. The exchange of computer-stored messages by network communication.

electrophotographic drum A central part of the laser printer that acquires the toner to be printed on paper.

electrostatic discharge (ESD) The discharge of static electricity from one conductor to another conductor of a different potential.

encryption A security feature that applies coding to a file so that only authorized users can view the file.

Encryption File System (EFS) A Microsoft-specific file system for encryption.

Enhanced Integrated Drive Electronics (EIDE) An enhanced version of the standard IDE interface that connects hard disks, CD-ROM drives, and tape drives to a PC.

Ethernet A baseband LAN specification invented by Xerox Corporation and developed jointly by Xerox, Intel, and Digital Equipment Corporation. Ethernet networks use CSMA/CD and run on a variety of cable types at 10 Mbps or more. Ethernet is similar to the IEEE 802.3 series of standards.

Ethernet port An RJ-45 socket that is used to connect a computer to a cabled LAN.

event A network message indicating operational irregularities in physical elements of a network or a response to the occurrence of a significant task, typically the completion of a request for information.

Event Viewer An application that monitors system events, application events, and security events.

exhaust vent An outlet that expels hot air from the interior of a device or room.

expansion card modem A modem that is inserted into a motherboard expansion slot (ISA or PCI). Also called an internal modem.

expansion slot An opening in a computer where a PC card can be inserted to add capabilities to the computer.

ExpressCard A high-throughput laptop expansion card standard that was developed by the PCMCIA. The ExpressCard expansion slot uses the built-in PCI Express (x1) and/or USB bus of a laptop. ExpressCards have a 26-pin connector and are hot-swappable.

extended memory Memory above 1 MB.

extended partition The second partition on the hard drive.

extended-star topology A star topology that is expanded to include additional networking devices.

external hard drive A device that connects to the computer to provide additional data storage.

external modem A modem that connects to the serial port (COM1 or COM2) of most computers. An external modem, such as a cable modem, typically is used for high-speed connections.

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F

Fast Ethernet Any of a number of 100-Mbps Ethernet specifications. Fast Ethernet offers a speed increase ten times that of the 10BASE-T Ethernet specification while preserving such qualities as frame format, MAC mechanisms, and MTU. Such similarities allow the use of existing 10BASE-T applications and network management tools on Fast Ethernet networks. Based on an extension to the IEEE 802.3 specification. Compare with Ethernet.

FDISK A command used to delete and create partitions on the hard drive. The **:\STATUS** switch displays partition information when used with the **FDISK** command.

Fiber Distributed Data Interface (FDDI) A type of Token Ring network that is used in larger LANs.

fiber-optic cable A physical medium that can conduct modulated light transmission. Compared with other transmission media, fiber-optic cable is more expensive, but it is not susceptible to electromagnetic interference, and it is capable of higher data rates. Sometimes called optical fiber. Uses glass or plastic wire, also called fiber, to carry information as light pulses. Conducts modulated light to transmit data.

field-replaceable unit (FRU) A component that a trained service technician may install at a remote location.

file A block of logically related data that is given a single name and is treated as a single unit.

file allocation table (FAT) A table that the operating system uses to store information about the location of the files stored on a disk. This file is stored in track 0 on the disk.

file extension A designation that describes the file format or the type of application that created a file.

file management A hierarchical structure of files, folders, and drives in Windows.

file system The two file systems available in Windows XP and Windows Vista are FAT32 and NTFS. NTFS has greater stability and security features.

File Transfer Protocol (FTP) A set of rules governing how files are transferred. FTP allows multiple simultaneous connections to remote file systems.

fingerprint reader An input device that scans fingerprints to authenticate login using biometric identification.

firewall A router or access server, or several routers or access servers, designated as a buffer between any connected public networks and a private network. A firewall router uses access lists and other methods to ensure the security of the private network.

Firewire A high-speed, platform-independent communication bus. Firewire interconnects digital devices such as digital video cameras, printers, scanners, digital cameras, and hard drives. Firewire is also known as IEEE 1394, i.Link (Sony-proprietary), and linear heat-detecting cable (LHDC) in the U.K.

firmware A program that is embedded in a silicon chip rather than stored on a floppy disk.

flash memory A rewritable memory chip that retains data after the power is turned off.

flat-head screwdriver A tool used to loosen or tighten slotted screws.

floppy data cable An external cable that transfers data between the computer and the floppy drive.

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floppy disk drive (FDD) A device that spins a magnetically coated floppy disk to read data from it and write data to it.

floppy drive cable An external cable that connects the computer and the floppy drive.

format To prepare a file system in a partition to store files.

form factor The physical size and shape of computer components. Components that share the same form factor are physically interchangeable.

full backup Backs up all files on a disk. Also called a normal backup.

full-duplex transmission Data transmission that can go two ways at the same time. An Internet connection using DSL service is an example.

function key (Fn key) A modifier key usually found on laptop computers. It is used in combination with other keys to perform specific functions.

G

gamepad An external controller used as an input device, primarily for gaming.

gigahertz (GHz) A common measurement of a processor equal to one billion cycles per second.

Global System for Mobile Communications (GSM) A worldwide cellular network.

graphical user interface (GUI) An interface that allows the user to navigate through the operating system using icons and menus.

graphics application Creates or modifies graphical images. The two types of graphical images include object- or vector-based images, and bitmaps or raster images.

Graphics Device Interface (GDI) A Windows component to manage how graphical images are transmitted to output devices. GDI works by converting images to a bitmap that uses the computer instead of the printer to transfer the images.

grayware Spyware that installs on a computer without being prompted and downloads additional applications without permission from the user.

H

half-duplex transmission Data transmission that can go two ways, but not at the same time. A two-way radio is an example.

handshaking sequence A series of short communications that occur between two modems. This establishes the readiness of the two modems and computers to engage in data exchange.

handwriting recognition The ability of computers, especially mobile devices, to recognize letters and numbers written by hand and convert them to ASCII text.

hard disk drive (HDD) A device that stores and retrieves data from magnetic-coated platters that rotate at high speeds. The HDD is the primary storage medium on a computer.

hardware Physical electronic components that make up a computer system.

Hardware Abstraction Layer (HAL) A library of hardware drivers that communicate between the operating system and the hardware that is installed.

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Hardware Compatibility List (HCL) A utility that verifies that existing hardware is compatible with an operating system.

hardware firewall A hardware device that filters data packets from the network before reaching computers and other devices on a network.

Hayes-compatible command set A set of AT commands that most modem software uses. This command set is named after the Hayes Microcomputer Products Company, which first defined it.

headphone jack A socket that is used to attach an audio output device.

heat sink and fan assembly A device that dissipates heat from electronic components into the surrounding air.

hex driver A driver used to tighten nuts. Sometimes called a nut driver.

hibernate/standby indicator LED A light that shows if the computer is in standby or hibernate mode.

hierarchical star topology An extended star topology in which a central hub is connected by vertical cabling to other hubs that are dependent on it.

High Data Rate DSL (HDSL) Provides bandwidth of 768 kbps in both directions.

High-Definition Multimedia Interface (HDMI) A video, plasma, LCD, or DLP projector.

HKEY_ The designation at the beginning of Windows Registry boot filenames.

host A computer system on a network. Similar to the term node, except that host usually implies a computer system. Node generally applies to any networked system, including access servers and routers.

hot-swappable interface Allows peripherals to be changed while the system is running. USB is an example.

hub 1) Generally, a term used to describe a Layer 1 device at the center of a star topology network. 2) A hardware or software device that contains multiple independent but connected modules of network and internetwork equipment. Hubs can be active (where they repeat signals sent through them) or passive (where they do not repeat, but merely split, signals sent through them). 3) In Ethernet and IEEE 802.3, an Ethernet multiport repeater, sometimes called a concentrator.

Hypertext Markup Language (HTML) A page-description language used by browser applications such as Windows Internet Explorer and Mozilla Firefox.

Hypertext Transfer Protocol (HTTP) Governs how files are exchanged on the Internet.

I

icon An image that represents an application or a capability.

IEEE 802.1 An IEEE specification that describes an algorithm that prevents bridging loops by creating a spanning tree. This algorithm was invented by Digital Equipment Corporation. The Digital algorithm and the IEEE 802.1 algorithm are not exactly the same, nor are they compatible.

IEEE 802.11 An IEEE standard that specifies carrier sense media access control and physical layer specifications for 1- and 2-Mbps wireless LANs.

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IEEE 802.11a An IEEE standard for wireless LANs that operates in the 5-GHz band. Uses 52-subcarrier orthogonal frequency-division multiplexing (OFDM) with a maximum raw data rate of 54 Mbps.

IEEE 802.11b The first widely accepted wireless networking standard. Because it operates in the 2.4-GHz band, other devices that operate in the same band can cause interference.

IEEE 802.llg An extension of the 802.11 standard. 802.11g applies to wireless LANs and provides up to 54 Mbps. Because it operates in the 2.4-GHz band, other devices that operate in the same band can cause interference.

IEEE 802.11n A proposed new extension to the 802.11 standard. 802.11n applies to wireless LANs and provides up to 540 Mbps in the 2.4- or 5-GHz band.

IEEE 802.12 An IEEE LAN standard that specifies the physical layer and the MAC sublayer of the data link layer. IEEE 802.12 uses the demand priority media access scheme at 100 Mbps over a variety of physical media.

IEEE 802.2 An IEEE LAN protocol that specifies an implementation of the LLC sublayer of the data link layer. IEEE 802.2 handles errors, framing, flow control, and the network layer (Layer 3) service interface. Used in IEEE 802.3 and IEEE 802.5 LANs.

IEEE 802.3 An IEEE LAN protocol that specifies an implementation of the physical layer and the MAC sublayer of the data link layer. IEEE 802.3 uses CSMA/CD access at a variety of speeds over a variety of physical media. Extensions to the IEEE 802.3 standard specify implementations for Fast Ethernet. Physical variations on the original IEEE 802.3 specification include 10BASE2, 10BASE5, 10BASE-F, 10BASE-T, and 10Broad36. Physical variations for Fast Ethernet include 100BASE-T, 100BASE-T4, and 100BASE-X.

IEEE 802.3i A physical variation on the original IEEE 802.3 specification that calls for using Ethernet-type signaling over twisted-pair networking media. The standard sets the signaling speed at 10 Mbps using a baseband signaling scheme transmitted over twisted-pair cable employing a star or extended star topology.

IEEE 802.4 An IEEE LAN protocol that specifies an implementation of the physical layer and the MAC sublayer of the data link layer. IEEE 802.4 uses token-passing access over a bus topology and is based on the token bus LAN architecture.

IEEE 802.5 An IEEE LAN protocol that specifies an implementation of the physical layer and MAC sublayer of the data link layer. IEEE 802.5 uses token passing access at 4 or 16 Mbps over shielded twisted-pair (STP) cabling and is similar to IBM Token Ring.

IEEE 802.6 An IEEE MAN specification based on Distributed Queue Dual Bus (DQDB) technology. IEEE 802.6 supports data rates of 1.5 to 155 Mbps.

impact printer A class of printer that includes dot matrix and daisy wheel.

incremental backup A procedure to back up all the files and folders that have been created or modified since the last full or normal backup.

infrared (IR) Electromagnetic waves whose frequency range is above that of microwaves but below that of the visible spectrum. LAN systems based on this technology represent an emerging technology.

infrared port A line-of-sight wireless transceiver that is used for data transmission.

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infrared scatter An infrared signal that is bounced off ceilings and walls. Devices can connect without line of sight, but data transfer rates are lower, and distances are shorter.

inkjet printer A type of printer that uses liquid-ink-filled cartridges that spray ink to form an image on the paper.

input/output (I/O) Any operation, program, or device that transfers data to or from a computer.

input/output (I/O) address A unique hexadecimal memory address that is associated with a specific device on a computer.

installation CD A compact disc that includes new software with drivers and manuals. Additionally, may include diagnostic tools and trial software.

instant messaging (IM) A real-time text-based method of communication conducted over a network between two or more users.

Institute of Electrical and Electronics Engineers (IEEE) An organization that oversees the development of communication and network standards.

insulation A high-resistance material that inhibits the flow of current between conductors in a cable.

Integrated Services Digital Network (ISDN) A communication protocol, offered by telephone companies, that permits telephone networks to carry data, voice, and other source traffic.

interface 1) A connection between two systems or devices. 2) In routing terminology, a network connection. 3) In telephony, a shared boundary defined by common physical interconnection characteristics, signal characteristics, and meanings of interchanged signals. 4) The boundary between adjacent layers of the OSI reference model.

Interior Gateway Protocol (IGP) An Internet protocol that is used to exchange routing information within an autonomous system. Examples of common Internet IGPs include EIGRP, OSPF, and RIP.

International Electrotechnical Commission (IEC) An industry group that writes and distributes standards for electrical products and components.

International Organization for Standardization (ISO) An international organization that sets standards for networking. ISO developed the OSI reference model, a popular networking reference model.

Internet The largest global internetwork. Connects tens of thousands of networks worldwide.

Internet Architecture Board (IAB) The board of internetwork researchers who discuss issues pertinent to Internet architecture. Responsible for appointing a variety of Internet-related groups, such as the IANA, IESG, and IRSG. The IAB is appointed by the trustees of the ISOC.

Internet Control Message Protocol (ICMP) Used for network testing and troubleshooting, ICMP enables diagnostic and error messages. The ping utility uses ICMP echo messages to determine whether a remote device can be reached.

Internet Message Access Protocol (IMAP) Used by local e-mail clients to synchronize and retrieve e-mail from a server and leave e-mail on the server.

Internet Protocol (IP) A network layer protocol in the TCP/IP stack that offers a connectionless internetwork service. IP provides features for addressing, type-of-service specification, fragmentation and reassembly, and security. Documented in RFC 791.

Internet service provider (ISP) A company that provides Internet and e-mail services to consumers and businesses.

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Internetwork Packet Exchange/Sequenced Packet Exchange (IPX/SPX) Used by Novell Netware. IPX is a connectionless communication. SPX is the transport layer (Layer 4 of the OSI reference model).

interrupt request (IRQ) A request from a device for communication with the CPU.

I/O shield A grounded metal plate installed in the rear of the case that enables the motherboard connectors to be accessed from the outside of the case.

isopropyl alcohol A colorless flammable chemical compound with a strong odor used to clean the contacts on computer components.

J

Java A programming language for applets to run within a web browser. Examples of applets include a calculator and a counter.

JavaScript A programming language developed to interact with HTML source code for interactive websites. Examples include a rotating banner and a popup window.

jumper An electrical contact point used to set a hard drive as master or slave.

K

keyboard An input device with multifunctional keys.

keyboard port A PS/2 socket used to attach an external keyboard.

kilobytes per second (KBps) A measurement of the amount of data that is transferred over a connection, such as a network connection. A data transfer rate of 1 KBps is a rate of approximately 1000 bytes per second.

L

laptop A small form factor computer designed to be mobile. Operates much the same as a desktop computer. Laptop hardware is proprietary and usually is more expensive than desktop hardware.

laptop battery A rechargeable battery that powers the laptop.

laptop connector A socket that is used to attach the laptop to a docking station.

laptop keyboard An input device that includes alphanumeric, punctuation, and special function keys.

laptop latch A lever used to open the laptop lid.

laser printer A type of printer that uses static electricity and a laser to form the image on the paper.

latent image In laser printers, the undeveloped image.

LCD monitor An output device that passes polarized light through liquid crystals to produce images on the screen.

light-emitting diode (LED) A type of semiconductor that emits light when current is passed through it. The LED indicates whether components inside the computer are on.

line-in connector A socket that is used to attach an audio source.

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line of sight A characteristic of certain transmission systems such as laser, microwave, and infrared systems in which no obstructions in a direct path between transmitter and receiver can exist.

liquid crystal display (LCD) A type of lightweight, high-resolution display that works by blocking light rather than creating it.

local-area network (LAN) A communication network that covers a small geographic area and is under the control of a single administrator.

local security policy A combination of security settings that define the security of the computer on which the settings reside.

logical drive A section that a partition is divided into.

logical topology The method (ring or bus) by which different computers and other equipment in a network communicate with one another. Contrast with physical topology.

loopback plug A diagnostic tool that redirects signals to the transmitting port to troubleshoot connectivity.

M

MAC address A standardized data link layer address that is required for every port or device that connects to a LAN. Other devices in the network use these addresses to locate specific ports in the network and to create and update routing tables and data structures. MAC addresses are 6 bytes long and are controlled by the Institute of Electrical and Electronics Engineers (IEEE). Also known as a hardware address, MAC layer address, burned-in address, or physical address.

main distribution facility (MDF) A building's primary communications room. Also, the central point of a star networking topology, where patch panels, hubs, and routers are located.

malware A term taken from the phrase malicious software. Malware is designed to infiltrate or damage a computer system without the user's knowledge.

Master Boot Record (MBR) A program on the first sector of a hard disk that starts the boot process. The MBR determines which partition is used to boot the system and then transfers control to the boot sector of that partition, which continues the boot process. The MBR allows programs such as DOS to load into RAM.

Material Safety and Data Sheet (MSDS) A fact sheet that identifies hazardous materials.

mean time between failures (MTBF) The average length of time that the device will work without failing. This information can be found in the manual or on the manufacturer's website.

media The plural form of medium. The various physical environments through which transmission signals pass. Common network media include twisted-pair, coaxial, and fiber-optic cable, and the atmosphere (through which microwave, laser, and infrared transmission occurs).

Media Access Control (MAC) The lower of the two sublayers of the data link layer defined by the Institute of Electrical and Electronics Engineers (IEEE). The MAC sublayer handles access to shared media, such as whether token passing or contention will be used. Also, the rules for coordinating the use of the medium on a LAN.

media-handling options Options by which a printer handles media, including the paper's orientation, size, and weight.

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megabit 1,048,576 bits (approximately 1 million bits).

megabits per second (Mbps) A common measurement of the amount of data that is transferred over a connection in one second. A data transfer rate of 1 Mbps is a rate of approximately 1 million bits or 1000 kilobits per second.

megabyte (MB) 1,048,576 bytes (or approximately 1 million bytes).

mesh grip A tool attached to the end of a cable to help pull cable.

mesh topology A method of connecting users that provides alternative paths for data. If one path is severed or unusable, the data can take an alternative path to its destination.

microphone An audio input device.

microphone jack A socket used to connect a microphone used for audio input.

microwave An electromagnetic wave that ranges from 1 to 30 GHz. Microwave-based networks are an evolving technology gaining popularity because of their high bandwidth and relatively low cost.

mobile processor A CPU that is optimized to use less power, allowing laptop batteries to last longer.

modem port An RJ-11 jack that connects a computer to a standard telephone line. The modem port can be used to connect the computer to the Internet, to send and receive fax documents, and to answer incoming calls.

modulator/demodulator (modem) A device that converts digital computer signals into a format that is sent and received over an analog telephone line.

Molex power connector A four-wire computer power connector used to connect many devices, such as optical drives and hard drives.

monitor A display device that works with the installed video card to present output from a computer. The clarity of a CRT monitor is based on video bandwidth, dot pitch, refresh rate, and convergence.

motherboard The main printed circuit board. Connects all the computer's components, such as the CPU, BIOS, memory, mass storage interfaces, serial and parallel ports, expansion slots, and controllers required for standard peripheral devices.

mouse port A PS/2 socket that is used to attach an external mouse.

MSCONFIG A Windows utility designed to aid in troubleshooting the operating system. Allows the user to edit start-up applications and access the BOOT.INI, SYSTEM.INI, and WIN.INI files.

multimeter A troubleshooting tool that measures electrical voltage, resistance, and current.

multimode Optical fiber that has a thicker core than single-mode. It is easier to make, can use simpler light sources (such as LEDs), and works well over short distances. This type of fiber allows light waves to be dispersed into many paths as they travel through the fiber.

multiprocessing To enable programs to share two or more CPUs.

Multipurpose Internet Mail Extensions (MIME) A standard that extends the e-mail format to include text in ASCII standard format, as well as other formats, such as pictures and word processor documents. Normally used in conjunction with SMTP.

multitask To run two or more applications at the same time.

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multithread To divide a program into smaller parts that can be loaded as needed by the operating system. Multithreading allows individual programs to be multitasked.

multiuser Two or more users running programs and sharing peripheral devices, such as a printer, at the same time.

My Computer icon A desktop icon that provides access to the installed drives and other computer properties.

N

near-letter quality (NLQ) A quality of print that is better than draft quality, but not as good as letter quality.

needle-nose pliers A tool with long and slender jaws that can be used to grasp small objects.

NetView An IBM network management architecture and related applications. NetView is a virtual telecommunications access method (VTAM) application used to manage mainframes in Systems Network Architecture (SNA) networks.

network A group of two or more electronic devices, such as computers, PDAs, and smartphones, that communicate with each other to share data and resources.

Network Access Point (NAP) The point at which access providers are interconnected.

network administration The task of maintaining and upgrading a private network that is done by network administrators.

Network Basic Input/Output System (NetBIOS) An application programming interface (API) used by applications on an IBM LAN to request services from lower-level network processes. These services might include session establishment and termination, and information transfer.

network cable The physical medium used to connect devices for communication.

network file service Allows documents to be shared over a network to facilitate the development of a project.

network indicator LED A light that shows the status of the network connection. The green link light indicates network connectivity. The other LED indicates traffic.

networking medium Material (either cable or air) by which signals are sent from one network device to another.

network interface card (NIC) A computer interface with the LAN. This card typically is inserted into an expansion slot in a computer and connects to the network medium.

network layer Layer 3 of the Open Systems Interconnection (OSI) reference model. This layer provides connectivity and path selection between two end systems. The network layer is the layer at which routing occurs. Corresponds roughly with the path control layer of the Systems Network Architecture (SNA) model. The OSI reference model includes the application layer, presentation layer, session layer, transport layer, network layer, data link layer, and physical layer.

network operating system (NOS) An operating system designed specifically to provide additional network features.

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network printer A printer connected to the computer network that is set up to be shared by multiple users.

network server A computer that provides some network services, such as file sharing, and that can handle multiple users and multiple jobs.

network topology The way in which computers, printers, and other devices are connected.

New Technology File System (NTFS) A type of file system that provides improved fault tolerance over traditional file systems, and also provides file-level security.

nibble Half a byte, or 4 bits.

node 1) The endpoint of a network connection or a junction common to two or more lines in a network. Nodes can be processors, controllers, or workstations. Nodes, which vary in routing and other functional capabilities, can be interconnected by links, and they serve as control points in the network. The term node is sometimes used generically to refer to any entity that can access a network, and it is frequently used interchangeably with device. 2) In Systems Network Architecture (SNA), the basic component of a network, and the point at which one or more functional units connect channels or data circuits.

noise Interference, such as EMI or RFI, that causes unclean power and may cause errors in a computer system.

nonbootable disk A damaged or missing disk, or a disk that does not contain one or more system boot files.

northbridge One of the two chips in the core logic chipset of a PC motherboard. It typically handles communications between the CPU, RAM, AGP, PCIe, and the southbridge core chip. Also called a Memory Controller Hub (MCH).

NSLOOKUP A command that returns the IP address of a given hostname. This command can also do the reverse and find the hostname for a specified IP address.

NTDETECT A program used by Intel-based systems to detect installed hardware.

Num Lock indicator LED A light that shows the on/off status of the ten-key number pad.

O

Ohm's Law The mathematical relationship between current, resistance, and voltage, in which voltage is equal to the current multiplied by the resistance.

operating system A software program that performs general system tasks, such as controlling RAM, prioritizing the processing, controlling input and output devices, and managing files.

optical drive A disk drive that uses a laser to read and/or write CDs and DVDs.

optical drive activity indicator LED A light that shows drive activity.

P

packet A logical grouping of information that includes a header that contains control information and usually user data. The term packet is most often used to refer to network layer units of data. The terms datagram, frame, message, and segment are also used to describe logical information groupings at various layers of the OSI reference model and in various technology circles.

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Page Description Language (PDL) Code that describes the contents of a document in a language that the printer can understand.

pages per minute (ppm) The measure of a printer's speed.

Parallel Advanced Technology Attachment (PATA) The standard for connecting hard drives and optical drives into computer systems. Uses a parallel signaling technology.

parallel ATA (PATA) data cable An internal cable that transfers data between the motherboard and an ATA drive.

parallel cable An external cable that connects the computer's parallel port to a printer or another parallel communications device. Also called a printer cable.

parallel port A socket used to connect a device such as a printer or scanner.

partition To divide memory or mass storage into isolated or logical sections. After a disk is partitioned, each partition behaves like a separate disk drive.

PC Card An expansion card used in laptops to conform to PCMCIA standards.

peer-to-peer computing Each network device runs both client and server portions of an application. Also describes communication between implementations of the same OSI reference model layer in two different network devices.

Personal Computer Memory Card International Association (PCMCIA) An industry trade association that defines laptop expansion card standards.

personal digital assistant (PDA) A standalone, handheld device with computing and communicating abilities.

Phillips-head screwdriver A tool used to tighten or loosen crosshead screws.

phishing A type of spam intended to persuade the recipient to provide the sender with information that will enable the sender to access the recipient's personal information.

physical layer Layer 1 of the Open Systems Interconnection (OSI) reference model. The physical layer defines the electrical, mechanical, procedural, and functional specifications to activate, maintain, and deactivate the physical link between end systems. Corresponds with the physical control layer in the Systems Network Architecture (SNA) model. The OSI reference model includes the application layer, presentation layer, session layer, transport layer, network layer, data link layer, and physical layer.

physical topology The physical layout of the components on the network.

piezoelectric For printers, an electrically charged plate changes the nozzle's size and shape. This change in size causes the nozzle to act like a pump. The pumping action forces ink out through the nozzle and onto the paper.

ping A simple but highly useful command-line utility that is included in most implementations of TCP/IP. Ping can be used with either the hostname or the IP address to test IP connectivity. Determines whether a specific IP address is accessible by sending an ICMP echo request to a destination computer or other network device. The receiving device then sends back an ICMP echo reply message.

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plain old telephone service (POTS) The regular phone system, which typically uses analog signals to transmit voice and data. Sometimes called the Public Switched Telephone Network (PSTN).

platen A large roller in a dot-matrix printer that applies pressure to keep the paper from slipping. If multiple-copy paper is used, the platen gap can be adjusted to the paper's thickness.

plug-and-play Technology that allows a computer to automatically configure the devices that connect to it.

point of presence (POP) The point of interconnection between the communication facilities provided by the telephone company and the building's main distribution facility.

port replicator A fixed base unit in which a laptop is inserted and can connect to peripheral devices.

power adaptor A device that transforms AC to DC to provide electricity to the computer and charge the battery.

power button A control that turns a device on and off.

power cable An external cable consisting of color-coded conductors that transfer electricity to a computer and attached electrical devices.

power line communication (PLC) A communication method that uses power distribution wires (local electric grid) to send and receive data.

power on indicator LED A light that shows the laptop's on/off status.

power-on self-test (POST) A diagnostic test of memory and hardware when the system is powered up.

power supply Converts AC (alternating current) into the lower voltages of DC (direct current), which powers all the computer's components. Power supplies are rated in watts.

presentation layer Layer 6 of the Open Systems Interconnection (OSI) reference model. This layer ensures that information sent by the application layer of one system can be read by the application layer of another. The presentation layer is also concerned with the data structures used by programs and therefore negotiates data transfer syntax for the application layer. Corresponds roughly with the presentation services layer of the Systems Network Architecture (SNA) model. The OSI reference model includes the application layer, presentation layer, session layer, transport layer, network layer, data link layer, and physical layer.

preventive maintenance Regular and systematic inspection, cleaning, and replacement of worn parts, materials, and systems.

preventive maintenance policy A detailed program that determines maintenance timing, the type of maintenance performed, and the specifics of how the maintenance plan is carried out.

primary corona wire A voltage device that erases the charge on the printing drum. Also called the grid or conditioning roller.

primary partition The first partition on a hard drive. A primary partition cannot be subdivided into smaller sections.

Primary Rate Interface (PRI) An ISDN interface to primary rate access. Primary rate access consists of a single 64-Kbps D channel plus 23 (T1) or 30 (E1) B channels for voice or data. Compare to BRI.

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Printer Control Language (PCL) Developed by Hewlett-Packard to allow software applications to communicate with HP and HP-compatible laser printers. PCL is now an industry standard for most printer types.

printer driver Software that must be installed on a PC so that the printer can communicate and coordinate the printing process.

printer network interface card (NIC) An adapter that the printer uses to access the network media.

printer-output option Determines how the ink or toner is transferred to the paper. Includes color management, print quality, and speed.

printer queue A temporary holding area for print jobs. The jobs in the queue are fed to the printer when it is ready for the next job.

print resolution The number of tiny dots that the print head places per inch on the paper when forming an image.

protected mode Allows programs to access more than 1 MB of physical memory. Also protects against misuse of memory, such as programs that cannot execute a data segment or write into a code segment.

protocol 1) A formal description of a set of rules and conventions that govern how devices on a network exchange information. 2) A field within an IP datagram that indicates the upper-layer (Layer 4) protocol that sent the datagram.

protocol data unit (PDU) A unit of data that is specified in a protocol of a layer of the OSI reference model. For example, the PDU for Layer 1 is bits or the data stream, Layer 2 is framing, Layer 3 is the packet, and Layer 4 is the segment.

proxy An entity that, in the interest of efficiency, acts on behalf of another entity.

Public Switched Telephone Network (PSTN) A general term that refers to the variety of telephone networks and services in place worldwide. Sometimes called plain old telephone service (POTS).

R

radio frequency (RF) A generic term that refers to frequencies that correspond to radio transmissions. Cable TV and broadband networks use RF technology.

radio frequency interference (RFI) Radio frequencies that create noise that interferes with information being transmitted across unshielded copper cabling.

random-access memory (RAM) Memory that temporarily stores data for processing by the CPU. Also called physical memory.

read-only memory (ROM) Memory that permanently stores prerecorded configuration settings and data on a chip that can only be read. This type of memory retains its contents when power is not being supplied to the chip.

Reduced Instruction Set Computer (RISC) An architecture that uses a relatively small set of instructions. RISC chips are designed to execute these instructions very rapidly.

Redundant Array of Independent Disks (RAID) Provides fault tolerance to prevent loss of data in the event of disk drive failure on a network server. Also known as Redundant Array of Inexpensive Disks.

Regedit A Windows application that allows users to edit the registry.

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registry A system-wide database used by the Windows operating system to store information and settings for hardware, software, users, and preferences on a system.

remote-access server (RAS) A server that is dedicated to users who need to gain access to files and print services on the LAN from a remote location.

remote installation services (RIS) The ability to download a Windows operating system installation across the network. This installation can be requested by the user or forced onto the computer by the administrator.

removable drive A drive that can be removed from a computer to transport data.

resistance (r) The measurement, expressed in ohms, of the opposition of a material to the flow of current.

resolution The number of distinct pixels in each dimension that can be displayed on a computer screen. The higher the resolution, the better quality the screen display is. Also called display resolution.

restore point A utility in Microsoft's Windows Me, XP, and Vista operating systems. It allows the rolling back of system files, registry keys, and installed programs to a previous state in the event of system failure. User data is unaffected by performing a restore point.

ring topology A network topology that consists of a series of repeaters connected to one another by unidirectional transmission links to form a single closed loop. Each station on the network connects to the network at a repeater. Although logically they are a ring, ring topologies are most often organized in a closed-loop star.

router A network layer device that uses one or more metrics to determine the optimal path along which network traffic should be forwarded. Routers forward packets from one network to another based on network layer information. Occasionally called a gateway, although this definition of gateway is becoming increasingly outdated.

Routing Information Protocol (RIP) An Interior Gateway Protocol (IGP) supplied with UNIX Berkeley Standard Distribution (BSD) systems. The most common IGP on the Internet. RIP uses hop count as a routing metric.

S

safe mode An option when booting the system that loads only the basic devices that Windows needs to run. It is used for troubleshooting.

satellite communication The use of orbiting satellites to relay data between multiple Earth-based stations. Satellite communications offer high bandwidth and broadcast capability at a cost that is unrelated to the distance between Earth stations. Because of the satellite's altitude, satellite communications can be subject to long propagation delays.

SCANDISK A Windows utility used to examine all files on a drive.

Secure Shell A network protocol that allows data to be exchanged over a secure channel between two computers.

security key fob A small radio system that communicates with the computer over a short range. The computer must sense the signal from the key fob before it accepts the user login name and password.

security keyhole A hard point in the case that is used to attach a security cable.

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segment A portion of a computer network in which every device communicates using the physical layer of the OSI reference model. Hubs and repeaters extend and become part of a network segment, whereas switches and routers define and separate network segments.

semiconductor Material used to make computer chips that can be either a conductor or an insulator, depending on the control signals applied to it. The most common semiconductor materials are silicon and germanium. These materials then have other materials added to them to increase conductivity.

serial advanced technology attachment A computer bus primarily designed to transfer data between a computer and storage devices.

serial cable An external cable that connects the serial port on the computer to a peripheral device.

serial data transfer The movement of single bits of information in a single cycle.

serial port A socket that is used to connect a device such as a mouse or trackball.

serial transmission A method of data transmission in which the bits of a data character are transmitted sequentially over a single channel.

server A repository for files, or other resources, that can be accessed and shared across a network by many users.

service level agreement (SLA) A contract that defines expectations between an organization and the service vendor to provide an agreed-upon level of support.

session layer Layer 5 of the Open Systems Interconnection (OSI) reference model. This layer establishes, manages, and terminates sessions between applications and manages data exchange between presentation layer entities. The OSI reference model includes the application layer, presentation layer, session layer, transport layer, network layer, data link layer, and physical layer.

shielded twisted pair (STP) A two-pair wiring medium used primarily with Token Ring networks. STP cabling has a layer of shielded insulation to reduce electromagnetic interference (EMI). Compare with UTP.

shortcut A key combination that activates a command.

Simple Mail Transfer Protocol (SMTP) An e-mail protocol servers use to send ASCII text messages. When augmented by the MIME protocol, SMTP can carry e-mail with pictures and documents. E-mail clients sometimes use SMTP to retrieve messages from an e-mail server. However, because of the limited capability to queue messages at the receiving end, other protocols such as POP or IMAP typically are used to receive e-mail.

simplex The capability for data transmission in only one direction between a sending station and a receiving station.

single-mode A fiber cable that has a very thin core. Uses a high-energy laser as a light source. Can transmit signals over longer distances than multimode fiber-optic cable.

site survey Physically inspecting a building to help determine a basic network topology.

Small Computer System Interface (SCSI) A parallel interface standard that supports multiple devices on the same cable and achieves faster data transmission rates than standard buses.

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Small Computer System Interface (SCSI) cable An external or internal cable that connects the SCSI controller to SCSI ports of multiple internal and external devices.

smart card A credit-card-sized device that includes a processor and memory. Used to store information and authenticate network users. Smart cards provide two-factor identification because the user must have both the card and a password to access the network.

software firewall An application on a computer that inspects and filters data packets.

solenoid A coil of wires that forms electromagnets that fire the pins in a dot-matrix printer.

solid-ink printer A printer that uses solid sticks of ink rather than toner or ink cartridges. Solid-ink printers produce high-quality images. The ink sticks are nontoxic and can be handled safely.

sound card An integrated circuit board that enhances a computer's audio capabilities.

southbridge A chip that implements the slower capabilities of the motherboard. It is connected to the CPU through the northbridge chip. Also called the Input/Output (I/O) Controller Hub (ICH).

spam Unsolicited e-mail.

speaker An audio output device.

spike A sudden increase in voltage that is usually caused by a lightning strike.

spoof To gain access to resources on devices by pretending to be a trusted computer.

spooling The process of loading documents into a buffer (usually an area on a hard drive) until the printer is ready to print the documents.

spyware Malware that monitors activity on the computer. The spyware then sends this information to the organization responsible for launching the spyware.

standby power supply (SPS) Battery backup that is enabled when voltage levels fall below normal.

standoff A barrier/screw used to physically separate parts—in particular, the system board—from the case.

star topology A LAN topology in which endpoints on a network are connected to a common central switch by point-to-point links. A ring topology that is organized as a star and implements a unidirectional closed-loop star instead of point-to-point links.

static RAM (SRAM) A type of RAM that retains its contents for as long as power is supplied. SRAM does not require constant refreshing, like dynamic RAM (DRAM).

static random-access memory (SRAM) Memory that holds data as long as voltage is applied. Used mainly as cache memory for the CPU.

stylus A writing utensil. Typically used as an input method for the touch-sensitive screens of PDAs and graphics tablets.

subnet mask The second group of numbers used when configuring an IP address on a device. End devices use the subnet mask to determine the network portion of an IP address.

subnetting A logical division of a network. It provides the means to divide a network, and the subnet mask specifies how it is subdivided.

surge Any voltage increase above 110 percent of the normal voltage carried by a power line.

surge protector A suppressor that regulates the voltage going to a device.

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surge suppressor A device that ensures that the voltage going to another device stays below a certain level.

S-video port A four-pin mini-DIN connector that is used to output video signals to a compatible device. S-video separates the brightness and color portions of a video signal.

switch 1) An operation that is added to a DOS command to modify the command's output. 2) A Layer 2 network device also known as a multiport bridge.

Symmetric DSL (SDSL) A version of a DSL service that provides the same speed for uploads and downloads.

symmetric encryption Encryption that requires both sides of an encrypted conversation to use an encryption key to be able to encode and decode the data. The sender and receiver must use the same key at the same time.

SYN flood Randomly opens TCP ports, tying up network equipment or computer resources with a large number of false requests, causing sessions to be denied to others. See also denial of service (DoS).

System Restore A Windows XP service that runs in the background and allows the user to restore the operating system to a predefined point in time.

T

tape drive A device used to back up data on a network server drive.

Taskbar A utility within Microsoft Windows that graphically represents open applications, computer contents, and other information. Also provides a way to quickly access these resources.

Task Manager Displays active applications and identifies those that are not responding so that they can be shut down.

Telecommunications Industry Association (TIA) An organization that develops standards that relate to telecommunications technologies. Together, the TIA and the Electronic Industries Association (EIA) have formalized standards, such as EIA/TIA-232, for the electrical characteristics of data transmission.

Telnet A remote-access application that provides remote terminal access between hosts on a network. As a troubleshooting tool, Telnet can verify the application layer software between source and destination stations. This is the most complete test mechanism available for the OSI reference model.

thermal compound A substance that increases thermal conductivity between the surface of two of more objects.

thermal paper Chemically treated paper with a waxy quality. It becomes black when heated. Most thermal printer print heads are the width of the paper. The paper is supplied in the form of a roll.

thermal printer A printer that marks special thermal paper by applying heat to areas of the paper that are to be darkened to represent characters.

thicknet Coaxial cable that was used in older networks and operated at 10 Mbps with a maximum length of 500 meters. Also called 10BASE5.

thinnet Coaxial cable that was used in older networks and operated at 10 Mbps with a maximum length of 185 meters. Also called 10BASE2.

three-claw part retriever A tool used to retrieve and manipulate small parts.

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Token Ring network Uses a ring topology and a token-passing methodology to create collision-free data transmission.

toner Powder-type ink used in laser printers and photocopiers to form text and images on printer paper.

topology The actual physical layout of a network. Or, in the case of a logical topology, the signal or data flows in a network.

torx screwdriver A tool used to tighten or loosen screws that have a star-shaped depression on the top, a feature that is mainly found on laptop screws.

touchpad A pressure-sensitive input pad that controls the cursor.

touch screen An interactive LCD or CRT monitor that detects when something is pressed on it.

tracert A Windows utility that traces the route that a packet takes from source computer to destination host.

track A complete circle around a hard-drive platter made up of groups of 512-byte sectors.

trackball A ball that is rotated to control the cursor.

trackpoint An input stick that controls the cursor.

Transmission Control Protocol (TCP) The primary Internet protocol for delivering data. TCP includes facilities for end-to-end connection establishment, error detection and recovery, and metering the rate of data flow into the network. Many standard applications, such as e-mail, web browsers, file transfer, and Telnet, depend on the services of TCP.

Transmission Control Protocol/Internet Protocol (TCP/IP) The common name for the suite of protocols developed by the U.S. Department of Defense (DoD) in the 1970s to support the construction of worldwide internetworks. TCP and IP are the two best-known protocols in the suite.

transport layer Layer 4 of the Open Systems Interconnection (OSI) reference model. This layer is responsible for reliable network communication between end nodes. The transport layer provides mechanisms for the establishment, maintenance, and termination of virtual circuits; transport fault detection and recovery; and information flow control. Corresponds to the transmission control layer of the Systems Network Architecture (SNA) model. The OSI reference model includes the application layer, presentation layer, session layer, transport layer, network layer, data link layer, and physical layer.

troubleshooting A systematic approach to locating the cause of a fault in a computer system.

tweezers A tool used to retrieve and manipulate small parts.

twisted pair A pair of insulated wires wrapped together in a regular spiral pattern to control the effects of electrical noise. The pairs can be shielded or unshielded. Twisted pair is common in telephony applications and data networks. Category 3, Category 5, Category 5e, and Category 6 twisted-pair cables all contain four twisted pairs in a common jacket.

U

unattended installation A custom installation of an operating system with minimal user intervention. Windows performs unattended installations by using an answer file called unattend.txt.

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Uninterruptible Power Supply (UPS) A device that maintains a continuous supply of electric power to connected equipment by supplying power from a separate source when utility power is unavailable.

universal bay status indicator LED A light that shows that a device is installed in the laptop bay.

Universal Serial Bus (USB) An external serial bus interface standard for the connection of multiple peripheral devices. USB can connect up to 127 USB devices at transfer rates of up to 480 Mbps and can provide DC power to connected devices.

Universal Serial Bus (USB) cable An external cable that connects the USB port on the computer to a peripheral device.

Universal Serial Bus (USB) port An external, hot-swappable, bidirectional connection for USB cables connecting to peripheral devices.

UNIX An operating system that is used primarily to run and maintain computer networks.

unshielded twisted pair (UTP) A four-pair wire medium used in a variety of networks. UTP is rated in categories, with higher categories providing the best performance and highest bandwidth. The most popular categories are Category 3, Category 5, Category 5e, Category 6, and Category 6A.

User Datagram Protocol (UDP) A connectionless service for delivery of data with less overhead than TCP and designed for speed. Network management applications, network file systems, and simple file transport use UDP.

user interface The part of the operating system that allows the user to communicate with the computer. User interfaces can provide a command-line interface (text) or graphical user interface (GUI).

user profile A specific setting for the user who is logged in to the computer.

V

ventilation A series of vents that allow hot air to be expelled from the interior of the device.

very high data rate DSL (VDSL) Broadband data transfer capable of bandwidths of 13 Mbps to 52 Mbps.

video accelerator card An integrated circuit board that contains a processor and memory to increase the speed of video graphics. Video accelerator cards are primarily used for 3D and gaming applications.

video adapter An integrated circuit board that stores digital data in VRAM and converts it to analog data.

video graphics array (VGA) Supplies analog video to an analog monitor. The connector is a 15-pin D-subtype connector.

video memory Dedicated random-access memory on a video graphics adapter (video RAM or VRAM). Also, an area of the system RAM shared with the CPU.

video surveillance equipment Used to record images and sound to monitor activity.

virtual Something that is conceptual rather than physical.

virtual memory Memory created and controlled by the operating system by manipulating free hard-disk space to mimic more RAM than is actually installed in the system.

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virtual private network (VPN) An encryption system that protects data as it travels, or tunnels, over the Internet or another unsecured public network.

virus In computer terms, a malicious piece of software or code that can copy itself and infect a computer without the user's knowledge or permission. Some viruses are benign and do not adversely affect a computer, whereas others can damage or delete operating system and data files.

virus scan A utility that checks all hard drives and memory for viruses.

Voice over IP (VoIP) A method to transmit telephone calls over the Internet using packet-switched technology.

volatile memory Computer memory that requires power to maintain the stored information.

voltage (V) A force that creates a current by moving electrons. Electromotive force or potential difference expressed in volts.

volume control A button that adjusts audio output.

W

warm boot Restarting a computer that is already turned on without first turning it off.

What You See Is What You Get (WYSIWYG) Printer output that matches what the user sees onscreen.

wide-area network (WAN) A data communications network that serves users across a broad geographic area and often uses transmission devices provided by common carriers. Frame Relay, SMDS, and X.25 are examples of WANs.

Wi-Fi A brand originally licensed by the Wi-Fi Alliance to define the embedded technology of a wireless network. Based on the IEEE 802.11 specifications.

Wi-Fi Protected Access (WPA) A security standard for Wi-Fi wireless technology. Provides better encryption and authentication than the earlier WEP system.

Windows Explorer A Windows utility that graphically represents the file-management structure.

wire cutters A tool used to strip and cut wires.

Wired Equivalent Privacy (WEP) A first-generation security standard for wireless technology.

wireless connection A connection to a network using radio signals, infrared technology (laser), or satellite transmissions.

wireless indicator LED A light that shows activity of the wireless network connection.

wireless network An extension of a wired network using radio frequency (RF) signals to connect to access points. Wireless signals can be repeated to additional access points, extending the network's distance.

wireless NIC An expansion card that enables a computer to connect to a wireless modem using RF signals.

Wireless Transport Layer Security (WTLS) A layer that provides security for mobile devices that use Wireless Application Protocol (WAP).

workgroup A collection of workstations and servers on a LAN that are designed to communicate and exchange data with one another.

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Z

zero insertion force (ZIF) socket A chip socket that permits the insertion and removal of a chip without using tools or force. This is common for delicate chips such as a CPU.

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