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 6	erasable programmable read-only memory (EPROM)
software page 6	page 20
Ohm's Law page 12	electrically erasable programmable read-only memory (EEPROM) page 20
central processing unit (CPU) page 15	random-access memory (RAM) page 20
cache page 17	dynamic RAM (DRAM) page 20
Reduced Instruction Set Computer (RISC) po	age 17 nonparity page 22
Complex Instruction Set Computer (CISC) po	age 17 parity page 22
hyperthreading page 17	NIC page 22
single-core CPU page 18	RAID adapter page 23
dual-core CPU page 18	USB port page 23
read-only memory (ROM) page 20	parallel port page 23
programmable read-only memory (PROM) pr	age 20 serial port page 23

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Industry Standard Architecture (ISA) page 23	High-Definition Multimedia Interface (HDMI)			
Extended Industry Standard Architecture (EISA)	page 33			
page 23	S-Video page 34			
Microchannel Architecture (MCA) page 23	Component/RGB page 34			
Peripheral Component Interconnect (PCI) page 23	CRT page 36			
Advanced Graphics Port (AGP) page 23	LCD page 37			
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Integrated Drive Electronics (IDE) page 26	pixel page 38			
Enhanced Integrated Drive Electronics (EIDE)	dot pitch page 38			
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Parallel ATA (PATA) page 26	interlaced/noninterlaced page 38			
Serial ATA (SATA) page 26	Horizontal Vertical Colors (HVC) page 38			
Small Computer System Interface (SCSI) page 26	aspect ratio page 38			
FireWire page 29	interrupt request (IRO) page 40			
PS/2 port page 32	input/output (I/O) port address page 41			
Video Graphics Array (VGA) page 33	Direct Memory Access (DMA) nage 42			
Digital Visual Interface (DVI) page 33	····· / ····· / ····· / ····· / ··· / ·			

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

- 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

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.

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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.

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.

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.





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 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.

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	1	✓	/

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 pro- grammable read-only memory (PROM)	1	1	1
+3.3V	Orange	Most newer CPUs, some types of system memory, and AGP video cards		/	1
+5V	Red	Motherboard, Baby AT and earlier CPUs, and many motherboard components	✓	/	1
-5V	White	ISA bus cards and early PROMS	<i>√</i>	<i>√</i>	✓
OV	Black	Ground: Used to complete circuits with the other voltages	✓	✓	 Image: A start of the start of

	Table 1-1	Power Color Codes	continued
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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.

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 the following:

- 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

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 WV = 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.



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.



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 northbridge 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.

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

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

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

 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)

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 *hyper-threading*, 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:

- *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.





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.





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.

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.

- 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.

- 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.





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.

- 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, and 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. 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)





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

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.

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.

- **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.

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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.

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



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.





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.



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).





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

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.





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.

- 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.



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

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.

- *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.

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

 Table 1-9
 Display Resolutions

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.



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.





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 the following:

- 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 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.			

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.

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

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
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		

 Table 1-11
 I/O Addresses
 continued

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.

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 print- ing port, and voice modems
2	Floppy disk controller	
3	Available	Network cards, SCSI adapters, parallel print- ing 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)

Table 1-12DMA Channels

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."

- 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

- 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