SUMMARY

DATA AND PROGRAM REPRESENTATION

Chapter Objective 1:
Understand how data and programs are represented to a computer and be able to identify a few of the coding systems used to accomplish this.

Most *digital computers* work in a two-state, or *binary*, fashion. It is convenient to think of these binary states in terms of 0s and 1s. Computer people refer to these 0s and 1s as *bits*. Converting data to these 0s and 1s is called *digital data representation*.

While most individuals use the **decimal number system** to represent numbers and perform numeric computations, computers use the **binary numbering system**. Text-based data can be represented with one of several fixed-length binary codes. Two possible coding schemes are **ASCII** (**American Standard Code for Information Interchange**) and **EBCDIC** (**Extended Binary-Coded Decimal Interchange Code**). These systems represent single characters of data—a numeric digit, alphabetic character, or special symbol—as strings of **bits**. Each string of eight bits is called a **byte**. **Unicode** is a newer coding system that can represent text in all written languages, including those that use alphabets different from English, such as Chinese, Greek, and Russian.

The storage capacity of computers often is expressed in **kilobytes** (**KB**), or thousands of bytes; **megabytes** (**MB**), millions of bytes; **gigabytes** (**GB**), billions of bytes; and **terabytes** (**TB**), trillions of bytes. Other possibilities are the **petabyte** (**PB**), about 1,000 terabytes; the **exabyte** (**EB**), about 1,000 petabytes; the **zettabyte** (**ZB**), about 1,000 exabytes; and the **yottabyte** (**YB**), about 1,000 zettabytes.

The binary system can represent not only text but also graphics, audio, and video data. **Machine language** is the binary-based code through which computers represent program instructions. A program must be translated into machine language before the computer can execute it.

INSIDE THE SYSTEM UNIT

Chapter Objective 2:
Explain the functions of the hardware components commonly found inside the system unit, such as the CPU, memory, buses, and expansion cards.

PCs typically contain a variety of hardware components located inside the **system unit**. For instance, *chips* are mounted onto *circuit boards*, and those boards are positioned in slots on the **motherboard** or *system board*—the main circuit board for a PC. Every PC has a **central processing unit** (**CPU**)—also called a **processor** or a **microprocessor** when referring to PCs—attached to its motherboard that performs the processing for the computer. CPU chips differ in many respects, such as what types of PCs the CPU is designed for, its *clock speed*, and *word size*. They can also be *multi-core CPUs*, such as the **dual-core** (two cores) and **quad-core** (four cores) **CPUs** now available. Another difference is the amount of **cache memory**—memory located on or very close to the CPU chip to help speed up processing. Other important differences are the general architecture of the CPU and the bus speed and width being used. The overall *processing speed* of the computer determines its performance. One of the most consistent measurements of overall performance is a *benchmark test*.

The main memory chips for a PC are commonly referred to as **RAM** (**random access memory**). RAM is volatile and used to temporarily hold programs and data while they are needed. RAM is available in different types and speeds. **ROM** (**read-only memory**) are memory chips that store nonerasable programs. **Flash memory** is nonvolatile memory that can be erased and reprogrammed in blocks. Flash memory chips can be found in PCs and mobile devices; flash memory chips can also be used for storage with portable PCs, digital cameras, and other smaller devices. **Registers** are memory built into the CPU chip to hold data before or during processing.

Most desktop PCs contain internal **expansion slots**, into which users can insert **expansion cards** to give the computer added functionality. A computer **bus** is an electronic path along which bits are transmitted. The parts of the *system bus* (the *frontside bus* and the *memory bus*) move data between the CPU and RAM, and **expansion buses** connect the CPU to peripheral devices. Common buses include *PCI*, **PCI Express** (**PCIe**), *AGP*, *HyperTransport*, **Universal Serial Bus** (**USB**), and **FireWire**.

System units typically have external **ports** that are used to connect peripheral devices to the computer. Notebook and tablet PCs may have fewer ports than desktop PCs. Handheld PC and mobile device users often add new capabilities with *Secure Digital* (*SD*) *cards* or other types of flash memory cards. **ExpressCard modules** can be used to add additional capabilities to PCs containing an *ExpressCard slot*. Some handheld PCs and mobile devices have a proprietary expansion system.

Chapter Objective 3:
Describe how peripheral devices or other hardware can be added to a PC.

HW

HOW THE CPU WORKS

CPUs today include at least one **arithmetic/logic unit** (**ALU**), which performs integer arithmetic and logical operations on data, and most include at least one **floating point unit** (**FPU**), which performs decimal arithmetic. The **control unit** directs the flow of electronic traffic between memory and the ALU/FPU and also between the CPU and input and output devices. Registers—high-speed temporary holding places within the CPU that hold program instructions and data immediately before and during processing—are used to enhance the computer's performance. The **prefetch unit** requests data and instructions before or as they are needed, the **decode unit** decodes the instructions input into the CPU, internal cache stores frequently used instructions and data, and the **bus interface unit** inputs data and instructions from RAM.

The CPU processes instructions in a sequence called a **machine cycle**, consisting of four basic steps. Each machine language instruction is broken down into several smaller instructions called *microcode*, and each piece of microcode corresponds to an operation (such as adding two numbers located in the CPU's registers) that can be performed inside the CPU. The computer system has a built-in **system clock** that synchronizes all of the PC's activities.

Chapter Objective 4:
Understand how the computer system's CPU and memory components process program instructions and data.

MAKING COMPUTERS FASTER AND BETTER NOW AND IN THE FUTURE

There are several possible remedies for a computer that is performing too slowly, including adding more memory, performing system maintenance to clean up the PC's hard drive, buying a larger or additional hard drive, and upgrading the computer's Internet connection or video card, depending on the primary role of the computer and where the processing bottleneck appears to be. To make computers work faster overall, computer designers have developed a number of strategies over the years, and researchers are continually working on new strategies. Some of the strategies already being implemented include improved architecture, **pipelining**, **multiprocessing**, **parallel processing**, and the use of improved materials.

Chapter Objective 5:
Name and evaluate several strategies that can be used today for speeding up the operations of a computer.

One possibility for future computers is **nanotechnology** research, which focuses on building computer components at the individual atomic and molecular levels. Some products (such as NRAM and bikes) using *carbon nanotubes* are currently on the market. **Quantum computing** and **optical computers** are other possibilities being researched, along with *three-dimensional* (*3D*) *chips*.

Chapter Objective 6:
List some processing technologies that may be used in future PCs.