SUMMARY

STORAGE SYSTEM CHARACTERISTICS

Chapter Objective 1: Name several general characteristics of storage systems.

Storage systems make it possible to save programs, data, and processing results for later use. They provide **nonvolatile** storage, so when the power is shut off, the data stored on the storage medium remains intact. This differs from RAM, which is **volatile**. All storage systems involve two physical parts: A **storage device** and a **storage medium**. The most common types of storage media are magnetic disks and optical discs, which are read by the appropriate type of drive. Drives can be *internal*, *external*, or *remote*. Drives are typically assigned letters by the computer; these letters are used to identify the drive. Storage devices can record data either on *removable* or *fixed media*. Removable media provide the advantages of unlimited storage capacity, transportability, safer backup capability, and security. Fixed media have the advantages of higher speed, lower cost, and greater reliability.

Sequential access allows a computer system to retrieve the records in a file only in the same order in which they are physically stored. *Random access* (also called *direct access*) allows the system to retrieve records in any order. In either case, **files** (sometimes called *documents*) stored on a storage medium are given a **filename** and can be organized into **folders**. This is referred to as *logical file representation*. *Physical file representation* refers to how the files are physically stored on the storage medium by the computer.

MAGNETIC DISK SYSTEMS

Chapter Objective 2: Describe how magnetic disk systems (such as hard drives) work.

Magnetic disk systems typically use *hard disks* or *floppy disks*. Magnetic disks have concentric **tracks** encoded with magnetized spots representing 0s and 1s. **Sector** boundaries divide a magnetic disk surface into pie-shaped pieces. The smallest amount of disk space that can be allocated to hold a file is comprised of one or more sectors and called a **cluster**. Computer systems originally used **floppy disks** because they provided a uniform removable storage system at a low cost. To use a floppy disk, it is inserted into a **floppy disk drive**.

Hard disk drives (also called **hard drives** and **HDDs**) are the main storage medium for most PCs. They offer faster access than floppy disks and much greater storage capacity. A hard drive contains one or more *hard disks* permanently sealed inside the hard drive, along with an *access mechanism*. A separate read/write head corresponds to each disk surface, and the access mechanism moves the heads in and out among the tracks to read and write data. All tracks in the same position on all surfaces of all disks in a hard drive form a disk **cylinder**. Hard drives can be divided into multiple *partitions* (logical drives) for efficiency or to facilitate multiple users or operating systems. Hard drives can be *internal* or *external*.

The total time it takes for a hard drive to read from or write to disks is called **disk access time**. A **disk cache** strategy, in which the computer transfers additional data to RAM whenever disk content is retrieved, can help to speed up access time. Hard drives can be *internal* or *external* and connect to a computer using one of several standards, such as *serial ATA* (*SATA*), *parallel ATA* (*PATA*), *serial attached SCSI* (*SAS*), *eSATA*, FireWire, or USB. If portability is required, *portable hard drives*, in which either the entire drive or a removable hard drive cartridge can be moved to another PC, are available. *Mini hard drives* are commonly integrated in mobile devices and consumer electronic products.

OPTICAL DISC SYSTEMS

Chapter Objective 3: Discuss the various types of optical disc systems available and how they differ from each other and from magnetic systems.

Optical discs store data *optically* using laser beams, and they can store data much more densely than magnetic disks. They are divided into tracks and sectors like magnetic disks, but use a single grooved spiral track instead of concentric tracks. Optical discs are available in a wide variety of *CD* and *DVD* formats and are read by *CD* or *DVD drives*. **CD-ROM discs** come with data already stored on the disc. Data is represented by *pits* and *lands* permanently formed on the surface of the disk. CD-ROM discs cannot be erased or overwritten—they are *read-only*. **DVD-ROM discs** are similar to CD-ROM discs, but they hold much more data (4.7 GB instead of 650 MB). High-capacity optical discs designed for high-definition content include **Blu-ray Discs** (**BD**) and **HD DVD discs**. *Recordable discs* (**CD-R**, **DVD-R/DVD+R**, and **DVD+R DL/DVD-R DL**, **BD-R**, and **HD DVD-R discs**) and *rewritable disks* (**CD-RW**, **DVD-RW/DVD+RW**, **BD-RE**, and **HD DVD-RW discs**) can all be written to, but only rewritable discs can be erased and rewritten to, similar to a floppy disk or hard drive. Recordable CDs and DVDs store data by burning permanent marks onto the disc, similar to CD-ROM and DVD-ROM discs; rewritable discs typically use *phase-change* technology to temporarily change the reflectivity of the disc to represent 1s and 0s.

FLASH MEMORY SYSTEMS

Chapter Objective 4: Identify some flash-memory-based storage devices and media and explain how they are used today.

Flash memory storage systems have no moving parts. **Flash memory cards**, the most common type of *flash memory media*, are commonly used with digital cameras, portable computers, and other portable devices, as well as with desktop PCs. Flash memory cards come in a variety of formats—the most common are *CompactFlash* (*CF*) and *Secure Digital* (*SD*) *cards*. **USB flash drives** connect to a PC via a USB port and are a convenient method of transferring files between computers. **Solid-state drives** (**SSDs**) contain flash memory media instead of magnetic disks; **hybrid hard drives** (**HHDs**) contain both magnetic metal discs and flash memory media. Flash-memory-based hard drives use less power than conventional hard drives; they are also more shock-resistant.

OTHER TYPES OF STORAGE SYSTEMS

Chapter Objective 5: List at least three other types of storage systems.

Remote storage—using a storage device that is not directly a part of your PC system—typically involves using a *network storage* device or an *online storage service*. **Smart cards** contain a chip or other circuitry usually used to store data or a monetary value. **Holographic storage**, which uses multiple blue laser beams to store data in three dimensions, is becoming available for high-speed data retrieval applications.

Storage systems for larger computers implement many of the same standards as PC-based hard drives. Instead of finding a single set of hard disks inside a hard drive permanently installed within a system unit, however, a **storage server** is often used. **Network attached storage** (**NAS**) and **storage area networks** (**SANs**) are commonly used to provide storage for a business network. **RAID** (**redundant arrays of independent disks**) technology can be used to increase *fault tolerance* and performance. **Magnetic tape** systems store data on plastic tape coated with a magnetizable substance. Magnetic tapes are usually enclosed in cartridges and are inserted into a *tape drive* in order to be accessed.

EVALUATING YOUR STORAGE ALTERNATIVES

Chapter Objective 6: Summarize the storage alternatives for a PC, including which storage systems should be included on a typical PC and for what applications other storage systems are appropriate.

Most PCs today include a hard drive, some type of CD or DVD drive, and a flash memory card reader. Most PCs also have a USB port that can be used to connect USB-based storage devices, such as external hard drives and USB flash drives. The type of optical drive and any additional storage devices are often determined by weighing a number of factors, such as cost, speed, compatibility, storage capacity, removability, and convenience.

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