

Chapter 2
Computer Hardware

Learning Objectives

1. Identify several types of input devices and explain their functions.
2. Explain the functions of the primary hardware components found inside the system unit, namely the motherboard, the CPU, and the memory.
3. List several output devices and explain their functions.
5. Understand the difference between storage and memory, as well as between a storage device and a storage medium.
6. Name several types of storage systems and explain the circumstances under which they are typically used.
7. Describe the purpose of communications hardware.

Digital Data Representation

- Most digital computers are binary computers
 - Understand only two states, off and on
 - Off and on are represented by the numbers 0 and 1
- All data processed by a binary computer must be in binary form
- Bits and Bytes
 - Bit
 - Smallest unit of data a binary computer can recognize
 - Typically represented by 1s and 0s
 - Derived from the term “binary digits”
 - Generally grouped together to form larger pieces of data
 - Byte
 - Eight bits
 - Prefixes are used to represent larger amounts of data (KB, MB, etc.)

Input Hardware

- Input Device
 - Any piece of hardware used to perform data input
- Keyboard
 - Used to type data into a computer
 - Can be integrated, wired, or wireless
 - Nearly always used with desktop and notebook computers
 - Many mobile phones have an integrated keyboard

FIGURE 2-4
Slide-out keyboards.



Photo courtesy of Nokia

Input Hardware

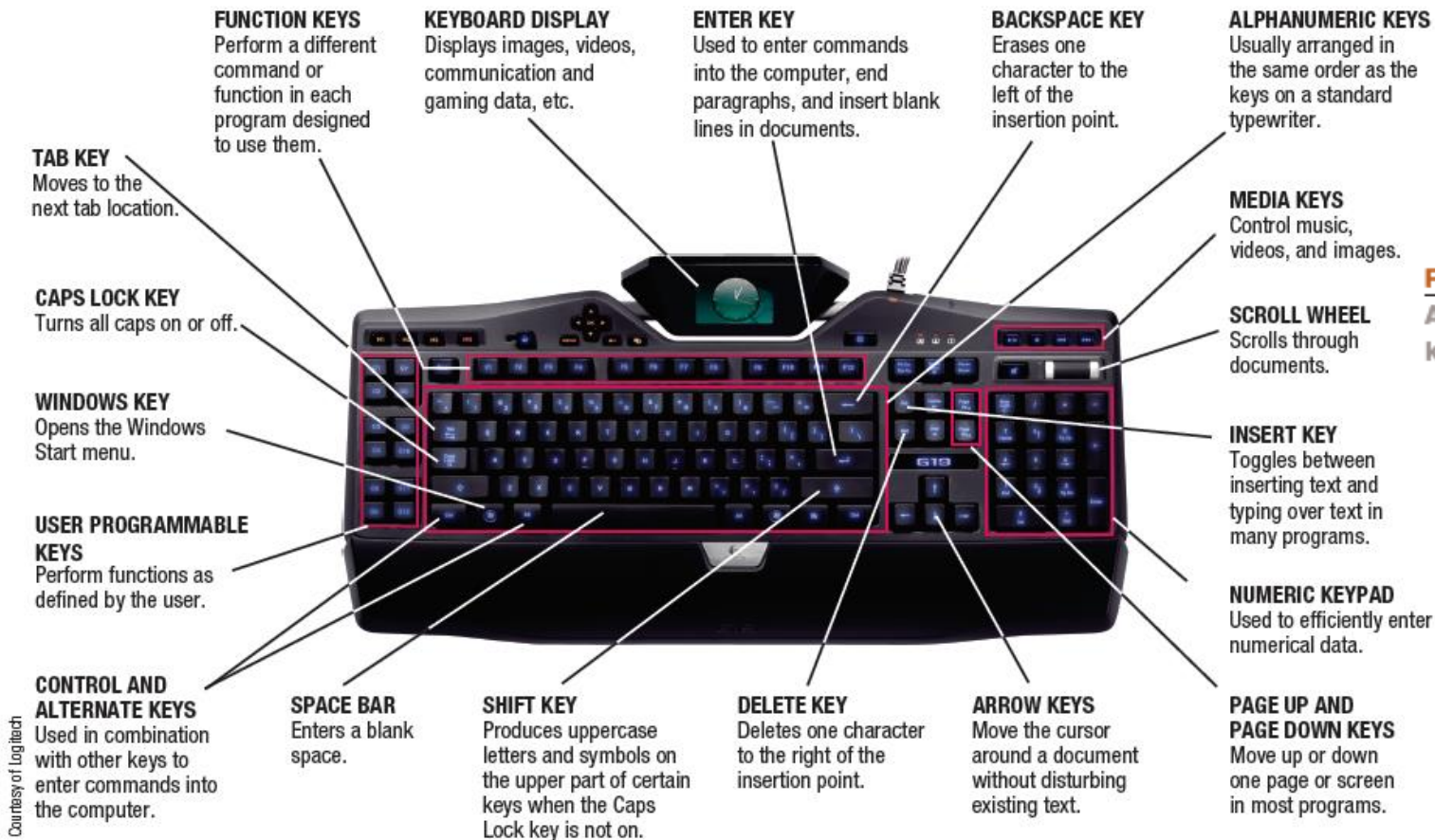


FIGURE 2-5
A typical desktop keyboard.

Courtesy of Logitech

Input Hardware

- Pointing Devices
 - Used to select objects, issue commands, etc. by pointing to and selecting objects
 - Two most common are the mouse and the pen stylus
 - Mice
 - Nearly always used with desktop computers; can be used with notebook computers
 - Most are either optical or laser mice
 - Used to start programs; open, move around, and edit documents; draw or edit images

Input Hardware







<p>POINT Move the mouse until the mouse pointer is at the desired location on the screen.</p>	
<p>CLICK Press and release the left mouse button.</p>	
<p>RIGHT-CLICK Press and release the right mouse button.</p>	
<p>DOUBLE-CLICK Press and release the left mouse button twice, in rapid succession.</p>	
<p>DRAG-AND-DROP When the mouse pointer is over the appropriate object, press and hold down the left mouse button, drag the object to the proper location on the screen by moving the mouse, and then drop the object by releasing the mouse button.</p>	
<p>SCROLL WHEEL/BUTTON If your mouse has a wheel or button on top, use it to scroll through the displayed document.</p>	

FIGURE 2-6
Common mouse operations.

steammoller_bluess/Shutterstock.com

Input Hardware

– Pens/Styluses

- Used to select items and/or write electronically on the screen
- Can be used with personal computers, mobile devices, and tablet computers
- Increasingly used for photography, graphic design, animation, and document processing

FIGURE 2-7

Examples of digital pen use.



Stylus

MOBILE DEVICES



TABLET COMPUTERS



GRAPHICS TABLETS



SIGNATURE CAPTURE DEVICES

Input Hardware

– Touch Screens

- Becoming common with personal computers, mobile phones, and other mobile devices
- Also used in consumer kiosks and POS systems
- Many are multi-touch
- Convenient for most users
- Not accessible for blind individuals and those with limited mobility
- Other pointing devices
 - Control buttons and wheels, touch pads, and gaming devices

Input Hardware



Courtesy of Samsung



Courtesy: Hewlett-Packard Company

TOUCH SCREENS

Commonly found on mobile devices and are increasingly being used with many types of computers today.



Courtesy of SanDisk Corporation

CONTROL BUTTONS

Commonly found on portable digital media players and other consumer devices.



Vlad109/Shutterstock.com

TOUCH PADS

Commonly found on notebook and netbook computers.

FIGURE 2-8

Examples of other common pointing devices.

Input Devices

- Other input devices
 - Scanners
 - Flatbed Scanner
 - Portable Scanner
 - Readers
 - Barcode Readers
 - RFID (radio frequency identification) Readers
 - Biometric Readers
 - Optical mark readers
 - Optical character readers
 - Magnetic ink character recognition readers

Input Devices

- Digital Cameras
- Microphones and headsets
 - Used for voice input
 - Commands, dictation, podcasts, etc.
- MIDI keyboards
 - Used to input original music
- Adaptive input devices
 - Designed for users with physical disabilities
- Ergonomic input devices
 - Designed to lessen the physical effects of computer use

Processing Hardware and Other Hardware Inside the System Unit

- System Unit
 - Main case of the computer
 - Components
 - Processing hardware, storage devices
 - Power supply, cooling fan
 - Interfaces used to connect peripheral devices
- The Motherboard
 - The main circuit board inside the system unit
 - All devices used with a computer connect in one way or another to the motherboard (directly, via port, etc.)

Processing Hardware and Other Hardware Inside the System Unit

– Ports

- Connectors exposed through the exterior of the system unit case
- Either built into the motherboard or created via expansion card
- Used to connect external devices to the computer (monitors, keyboards, mice, printers, etc.)
- ExpressCard slots used with notebook computers

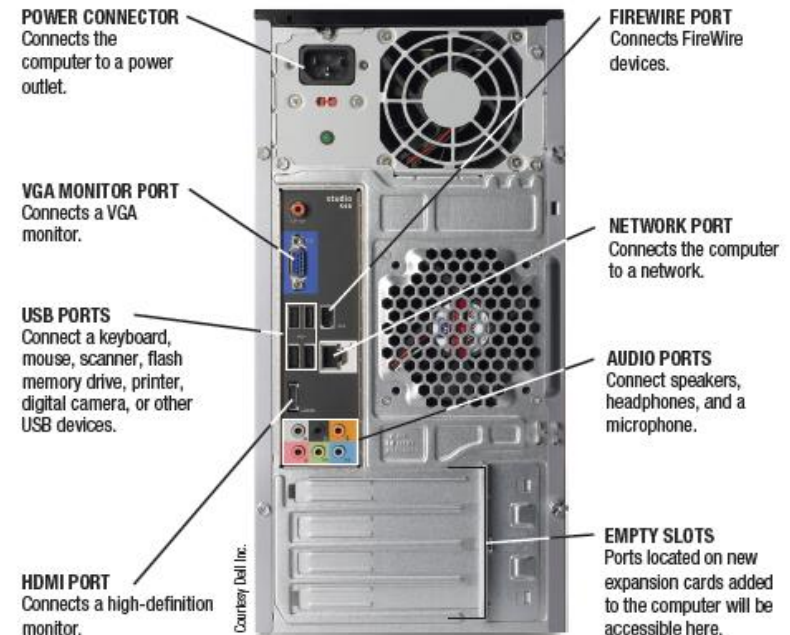


FIGURE 2-12
Ports are used to connect external devices to the motherboard.

Processing Hardware and Other Hardware Inside the System Unit

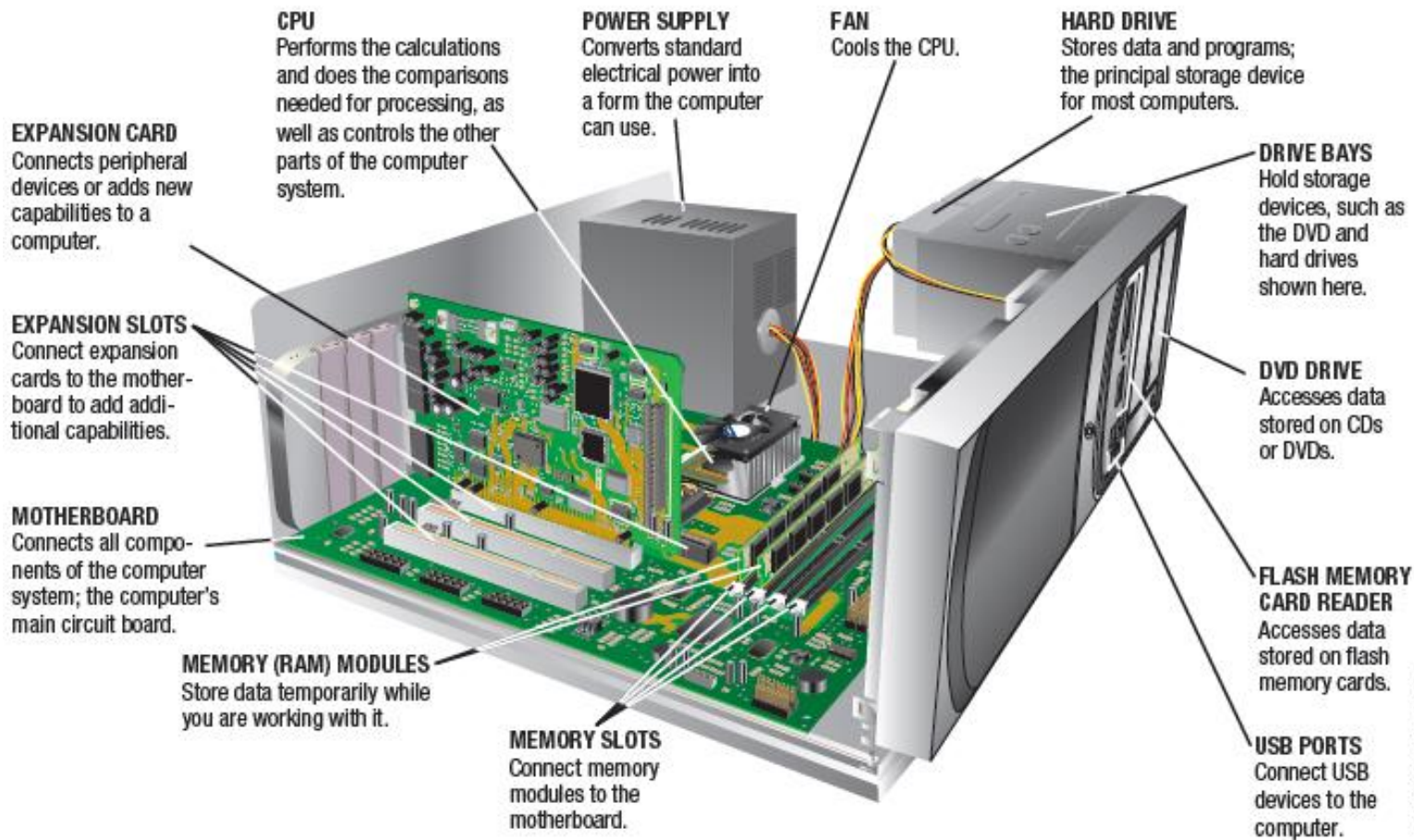


FIGURE 2-11
Inside a typical system unit. The system unit houses the CPU, memory, and other important pieces of hardware.

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Processing Hardware and Other Hardware Inside the System Unit

- The Central Processing Unit (CPU)
 - Consists of a variety of circuitry and components that are packaged together and connected directly to the motherboard
 - Also called a microprocessor or processor
 - CPU has two principal parts
 - Arithmetic/logic unit
 - Performs arithmetic involving integers and logical operations
 - Control unit
 - Coordinates and controls the actions taking place within the CPU

Processing Hardware and Other Hardware Inside the System Unit

- Most personal computers today use CPUs manufactured by Intel or Advanced Micro Devices (AMD) and are multi-core
- Measurements of CPU processing speed
 - CPU clock speed is measured in megahertz, MHz, or gigahertz, GHz

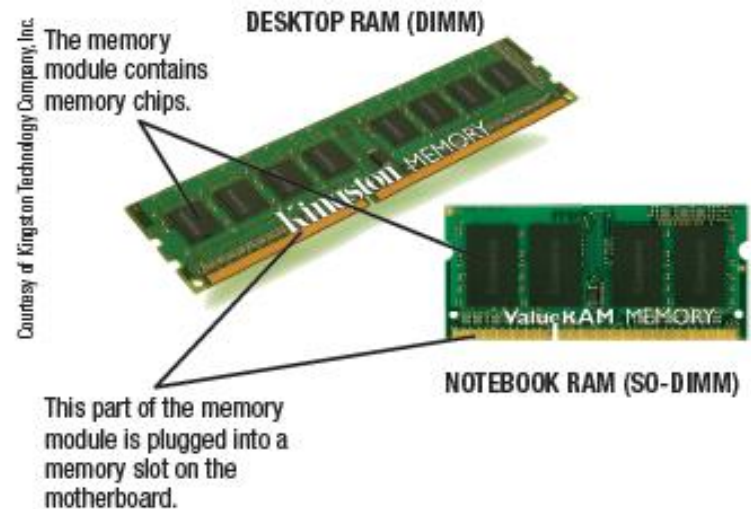
Processing Hardware and Other Hardware Inside the System Unit

- Memory
 - Refers to chip-based storage used by the computer – usually the amount of the computer’s main memory (random access memory or RAM)
 - RAM
 - Temporary (volatile) storage used by the computer
 - Used to store essential parts of the operating system while computer is running
 - Stores the programs and data currently being used by the computer
 - Content is lost when computer is shut down
 - Data is deleted from RAM when it is no longer needed

Processing Hardware and Other Hardware Inside the System Unit

- Consists of circuits etched onto chips arranged onto circuit boards called memory modules
- Capacity is measured in bytes
 - Computers must have enough RAM to run the necessary applications, as well as work efficiently
 - More RAM allows more programs to run at one time

FIGURE 2-14
RAM memory modules.



Processing Hardware and Other Hardware Inside the System Unit

- Other types of computer memory
 - Cache memory
 - Registers
 - ROM
 - Flash Memory

Output Hardware

- Display Devices
 - Most common type of output device
 - Displays output on some type of screen
 - Monitor
 - Display device for a desktop computer
 - Display screen
 - Built-in display device
 - Used with notebook computers, mobile phones, etc.
 - Used with many consumer products

FIGURE 2-15

Many consumer products today, such as the mobile tablet shown here, have a display screen.



ES tockphoto.com/pressureUA

Output Hardware

- Flat-panel displays
 - Form images by manipulating electronically charged chemicals or gasses sandwiched between panes of glass or other transparent surfaces
 - Take up less space and consume less power than the old cathode ray tube monitors
 - Thinner and lighter
 - Used with most computers and in mobile phones and other electronic devices

Output Hardware

– Pixel

- Smallest colorable area in an electronic image
- Number of pixels used on a display screen determines the screen resolution
- With high resolution, more information can fit on the screen, but everything will be displayed smaller than with a lower resolution

Output Hardware



1,280 × 768



1,600 × 900

FIGURE 2-16

Screen resolution.

A higher screen resolution (measured in pixels) displays more content than a lower screen resolution, but everything is displayed smaller.

GerhardAlonso/Shutterstock.com

Output Devices

- Printers
 - Produce hard copy –a permanent copy of the output on paper
 - Personal printers designed to be connected to a single computer
 - Network printers designed to be shared by multiple users via a network
 - Impact printers
 - Strike paper to transfer ink to paper

Output Devices

- Non-impact printers
 - Form images without touching the paper
 - Most common type of printer today
 - Much quieter than impact printers
 - Produce higher quality images
- Can be color or black-and-white
- Printer quality is measured in dots per inch (dpi)
- Printer speed is measured in pages per minute (ppm)

Output Devices

– Laser Printers

- Standard for business documents
- Come in personal and network versions
- Can be color or black-and-white
- Faster and of better quality than ink-jet printers
- Use technology similar to photocopier machines (toner powder, lasers, heat, etc.)
- Resolutions are between 600 and 2,400 dpi
- Speeds for personal laser printers range from 15 to 35 ppm

Output Devices

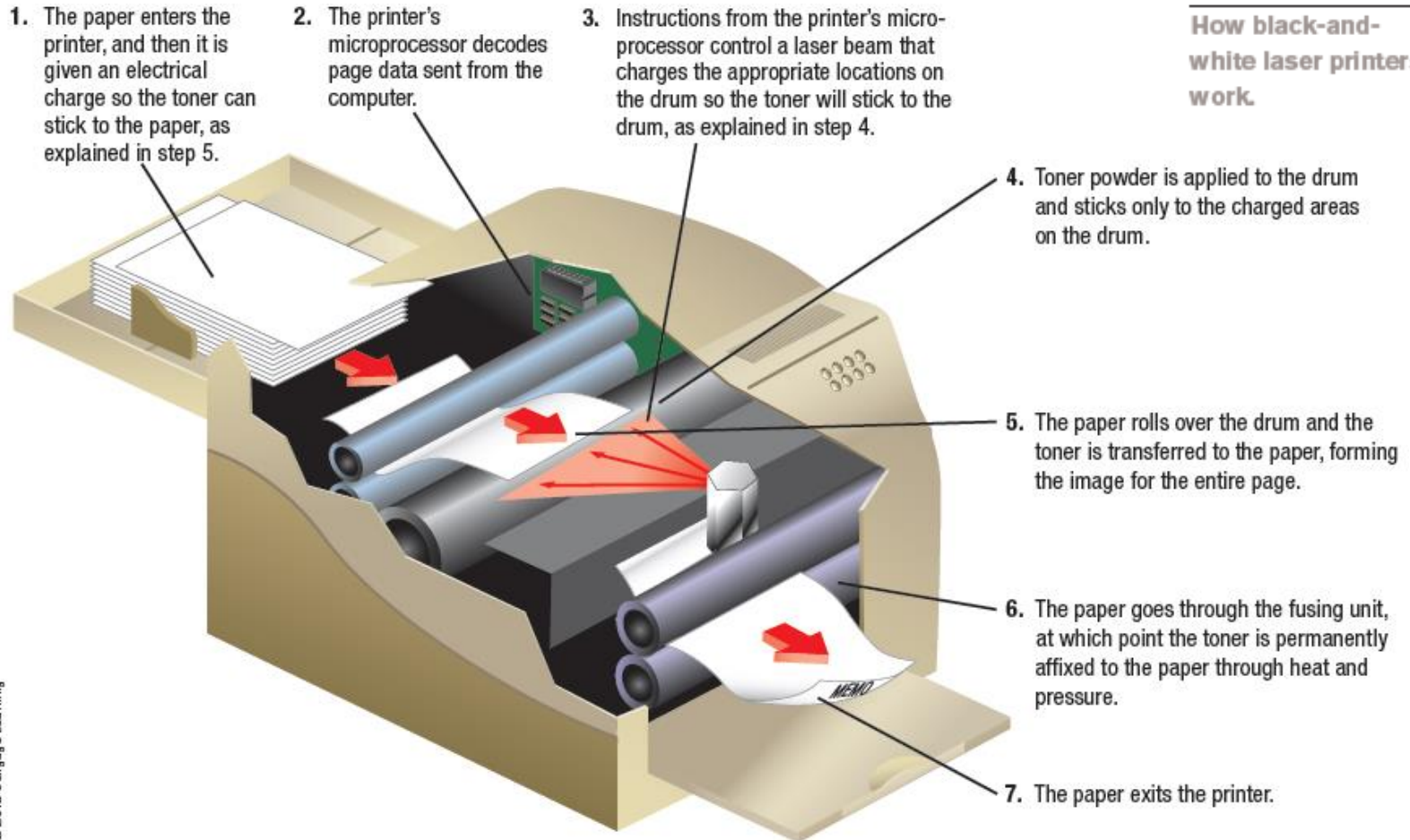


FIGURE 2-17
How black-and-white laser printers work.

Output Devices

– Ink-jet Printers

- Spray tiny drops of ink onto the page, one printed line at a time
- Some print using different-sized ink droplets, multiple nozzles, and varying electrical charges for precision
- Fairly inexpensive, although replacement ink cartridges can add up
- Good quality and usually can print in color
- Printer of choice for home use
- With special paper, ink-jet printers can print photos

Output Devices



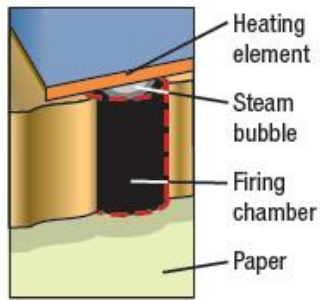
Each ink cartridge is made up of multiple tiny ink-filled firing chambers; to print images, the appropriate color ink is ejected through the appropriate firing chamber.



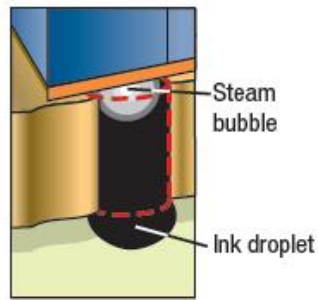
Courtesy Epson America

INK-JET PRINTER

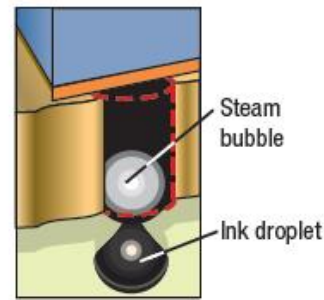
FIGURE 2-18
How ink-jet printers work.



1. A heating element makes the ink boil, which causes a steam bubble to form.



2. As the steam bubble expands, it pushes ink through the firing chamber.



3. The ink droplet is ejected onto the paper and the steam bubble collapses, pulling more ink into the firing chamber.

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Output Devices

- Special-Purpose Printers
 - Photo printers
 - Designed to print photographs
 - Barcode printers
 - Print barcodes
 - Portable printers
 - Designed to be carried with you to print while on the go
 - Plotters and wide-format ink-jet printers
 - Print large documents, such as blueprints and signs
 - 3D printers
 - Form a 3D replica of an object, typically using plastic powder

Output Devices

- Other Output Devices
 - Speakers
 - Headphones
 - Headsets
 - Earphones
 - Earbuds

Storage Hardware

- Storage System
 - Used to save documents for future use
 - Non-volatile
- Storage System Characteristics
 - Storage Media and Storage Devices
 - Storage Medium
 - The hardware where the data is actually stored
 - DVD, flash memory card, etc.

Storage Hardware

- Storage Devices
 - The device that reads data from or writes data to the storage medium
 - Internal
 - » Located inside the system unit
 - External
 - » Plugged into an external port on the system unit
 - Remote
 - » Located on another computer, such as a network server

Storage Hardware

- Types of Storage Technology Used
 - Data is usually stored magnetically or optically
 - Magnetic storage systems (hard drives) represent data using different magnetic alignments
 - Optical media, CDs and DVDs, use laser beams that burns permanent marks into the surface of the medium
 - Flash memory storage systems represent data using electrons

Storage Hardware

- Hard Drives
 - Used to store most programs and data
 - Both are increasingly coming with built-in encryption
 - Magnetic Hard Drives
 - Use metal hard disks or platters that are organized into tracks and sectors
 - Use Read/write heads to store (write) and retrieve (read) data

Storage Hardware

MOUNTING SHAFT

The mounting shaft spins the hard disks at a speed of several thousand revolutions per minute while the computer is turned on.

SEALED DRIVE

The hard disks and the drive mechanism are hermetically sealed inside a case to keep them free from contamination.



2.5-INCH HARD DRIVE LOCATED INSIDE A NOTEBOOK COMPUTER



INSIDE A 3.5-INCH HARD DRIVE

READ/WRITE HEADS

There is a read/write head for each hard disk surface, and they move in and out over the disks together.

HARD DISKS

There are usually several hard disk surfaces on which to store data. Most hard drives store data on both sides of each disk.

ACCESS MECHANISM

The access mechanism moves the read/write heads in and out together between the hard disk surfaces to access required data.

FIGURE 2-20
Magnetic hard drives.

Courtesy of Hitachi Global Storage Technologies; Courtesy Western Digital

Storage Hardware

- Solid-State Drives (SSDs) and Hybrid Hard Drives
 - Solid-State Drives
 - Use flash memory technology rather than spinning platters and magnetic technology
 - Use less power and have no moving parts
 - Not subject to mechanical failure
 - More resistant to shock and vibrations
 - Generate less heat
 - Make no noise
 - Operate faster
 - Attractive option for portable computers and mobile devices

Storage Hardware

- Hybrid Hard Drives
 - Use a combination of flash memory and a magnetic hard drive
 - Less expensive than an SSD
 - Can extend the battery life of portable computers and mobile devices
 - Can allow encryption and other security measures to be built into the drive

Storage Hardware

- Internal and External Hard Drives
 - Internal Hard Drives
 - Permanently located in the system unit
 - Almost all computers have at least one used to store programs and data
 - External Hard Drives
 - Used to move data from one computer to another
 - Can hold large amounts of data—500 GB to 4T
 - Used by individuals to hold digital pictures, digital music, home movies, recorded television shows
 - Portable hard drives are smaller external hard drives

Storage Hardware

- Most external and portable hard drives connect using a USB connection
- Some can connect using a wired or wireless networking connection



Image courtesy of iomega.com BMC company

PORTABLE HARD DRIVES (MAGNETIC)
Are about the size of a 3 by 5-inch index card, but thicker; this drive holds 1.5 TB.



Courtesy Transcend Information USA

EXPRESSCARD HARD DRIVES (SSD)
Fit into an ExpressCard slot; this drive holds 32 GB.

FIGURE 2-22
Portable hard drives.

Storage Hardware

- Optical Discs and Drives
 - Data on optical disks (DVDs, CDs, Blue-Ray) is stored and read optically, using laser beams
 - Data can be stored on one or both sides of the disc
 - Discs are divided into tracks and sectors, but use a single grooved spiral track beginning at the center of the disc
 - Lasers create and read marks created on the disc surface called pits and lands
 - With read-only discs, the pits are permanent
 - With recordable or rewritable discs, the pits are represented by changing the disc's reflectivity

Storage Hardware

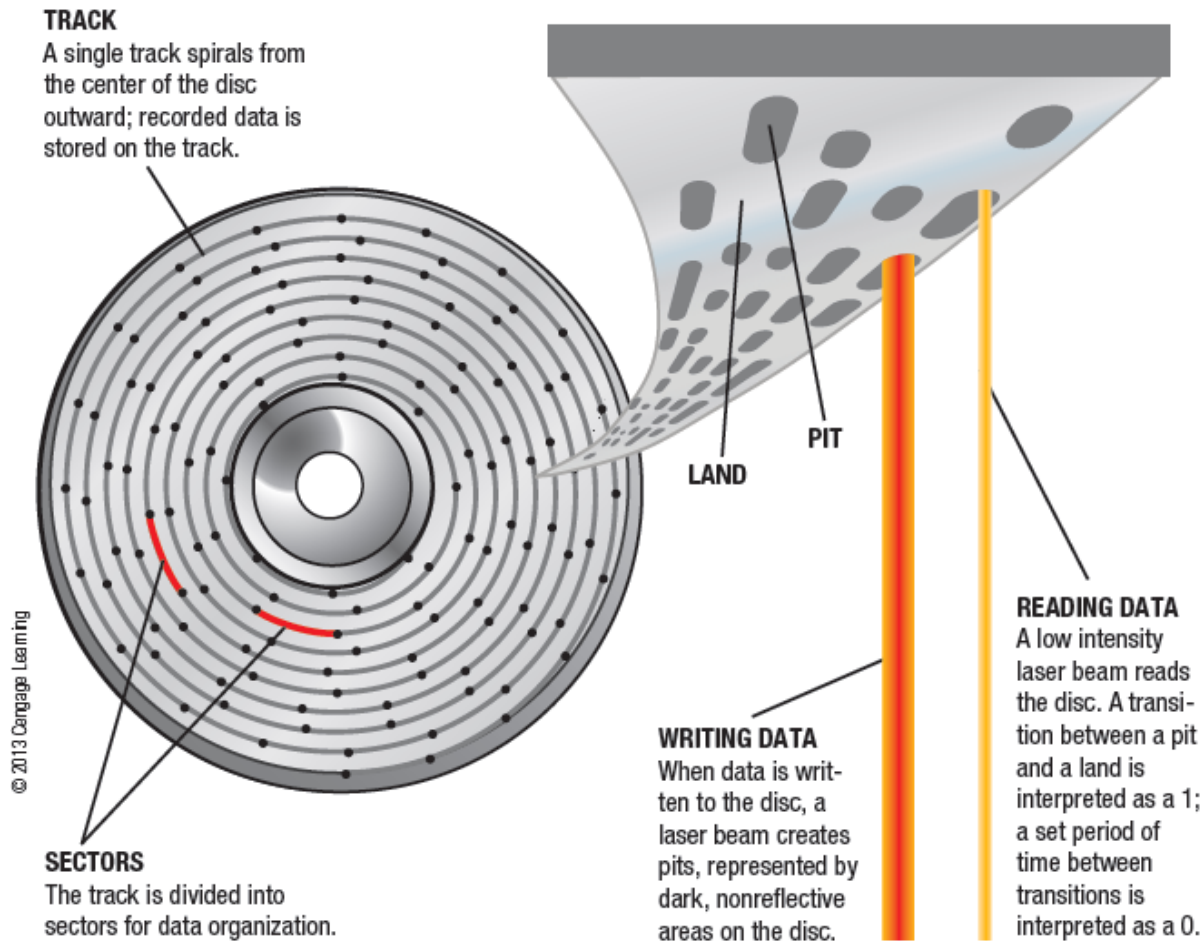


FIGURE 2-23
How recorded optical discs work.

Storage Hardware

- Conventional CDs
 - Use infrared lasers
- Conventional DVDs
 - Use red lasers
- High definition blue-ray discs
 - Use blue-violet lasers
 - More information can be stored (HD movies, etc.)
 - Data is recorded more compactly
- Discs come in various sizes
- Capacity depends on format, as well as the number of sides and layers, used

Storage Hardware



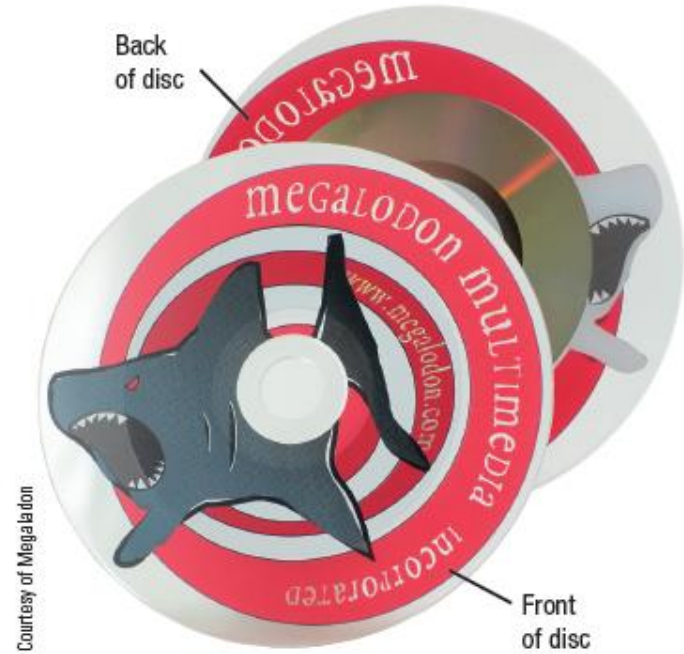
Courtesy of Adobe

STANDARD 120 MM (4.7 INCH) SIZED DISC



Courtesy Verbatim America LLC

MINI 80 MM (3.1 INCH) SIZED DISC



Courtesy of Megalodon

MINI 80 MM (3.1 INCH) SIZED DISC
(with a clear background to be standard size)

FIGURE 2-24

Optical discs are available in a variety of sizes, appearances, and capacities.

Storage Hardware

Types of discs

- Read-Only Discs: CD-ROM, DVD-ROM, and BD-ROM Discs
 - Come pre-recorded with commercial products
 - Data cannot be erased, changed, or added to
- Recordable Discs: CD-R, DVD-R, and BD-R Discs
 - Can be written to, but the discs cannot be erased and reused
 - Commonly used for:
 - Backing up files
 - Sending large files to others
 - Creating custom music CDs (CD-R)
 - Storing home movies, digital photos, multimedia files, etc. (DVD-R/+R)
 - Storing high-definition multimedia files (BD-R)

Storage Hardware

- Rewritable Discs: CD-RW, DVD-RW, DVD+RW, and BD-RE Discs
 - Can be written to, erased, and overwritten like magnetic disks
 - The correct drive must be used to write each type of disc
 - Used for similar purposes as recordable discs but are especially appropriate when data can later be erased and the disc reused

Storage Hardware

- Flash Memory Storage Systems
 - Chip-based storage medium that represents data using electrons
 - No moving parts, so are not as subject to mechanical failure as optical and magnetic media
 - Are more resistant to shock and vibration
 - Consume less power
 - Very small and quiet
 - Rewritable
 - Longer expected life than magnetic media
 - More expensive per MB, but very convenient and widely used with computers, digital cameras, etc.

Storage Hardware

- Flash Memory Cards and Readers
 - Commonly used with:
 - Desktop and portable computers
 - Digital cameras
 - Portable digital media players
 - Mobile phones and other mobile devices
 - Come in a variety of formats (SD cards, CompactFlash cards, MemoryStick, etc.)

Storage Hardware

Courtesy of Kingston Technology Company, Inc.



FLASH MEMORY CARD READERS

Can be built-in or external and usually support several different types of flash memory media; external readers such as this one typically connect to a computer via a USB port.



Courtesy of Kingston Technology Company, Inc.

COMPACTFLASH (CF) CARDS



Courtesy of Sony Electronics Inc.

MEMORY STICKS

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SECURE DIGITAL (SD) CARDS



Courtesy of Olympus

XD PICTURE CARDS

FIGURE 2-26

Flash memory cards. Shown here are some of the most widely used types of flash memory cards and a multicard reader.

Storage Hardware

– USB Flash Drives

- Flash memory media in self-contained unit that uses a USB interface
- Also called USB flash memory drives, thumb drives, and jump drives
- Are powered via the USB port
- Very portable
- Can be carried in a pocket or on a keychain
- Wide range of colors, sizes, appearances
- Capacity ranges from 2 GB to 256 GB
- Widely used to transfer files from one location to another

Storage Hardware



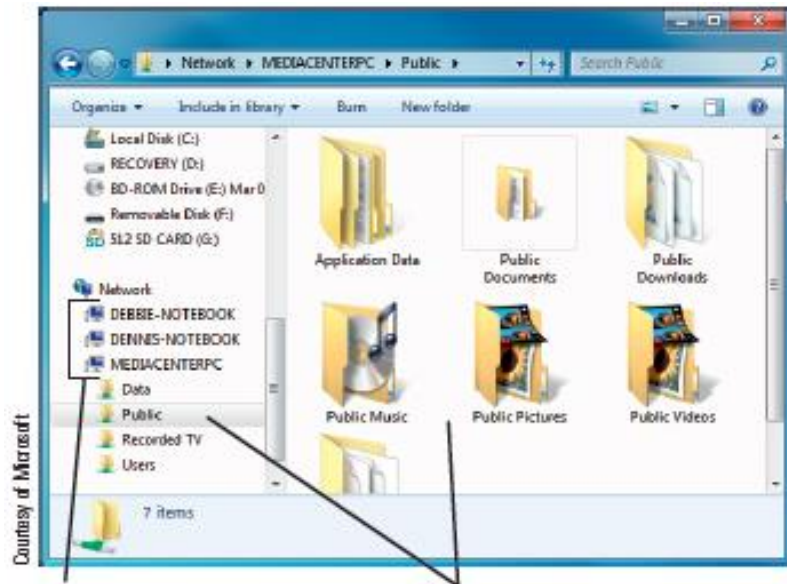
FIGURE 2-27

USB flash drives are often used to store data and transfer files from one computer to another.

Storage Hardware

- Other Types of Storage Systems
 - Remote Storage Systems
 - Use a storage device that is not connected directly to the user's computer
 - Accessed through a local network or the Internet
 - Often referred to as online storage or cloud storage
 - *Google Docs, Flickr, Facebook* provide online storage for these services
 - Windows Live *Skydrive* allows users to store documents online or “in the cloud”
 - » Files can be accessed from anywhere an Internet-abled device is available

Storage Hardware



Courtesy of Microsoft

Computers on this network.

Items in the Public folder on the computer called MEDIACENTERPC.

NETWORK STORAGE

Shared folders on network computers appear and are accessed in a manner similar to local folders.

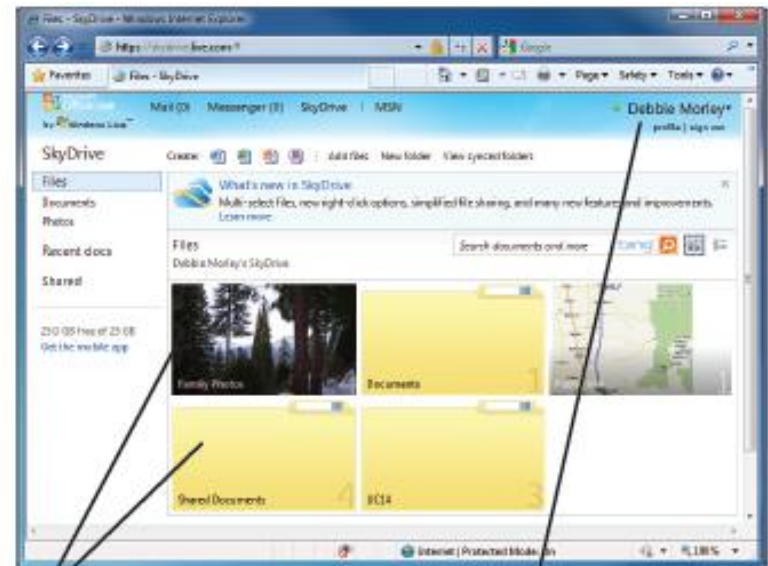


Image courtesy of Imomega an EMC company

Folders and files can be private or shared with others.

Users log on to see their personal files stored on the site's server.

CLOUD STORAGE

Files and folders are stored and accessed online; this site provides 25 GB of free storage.

FIGURE 2-28
Remote storage.

Communications Hardware

- Communications Hardware
 - Enables the user to communicate with others over a network or the Internet
- The type of communications device used depends on:
 - The device being used (desktop computer, notebook, mobile phone, etc.)
 - The communication standard being used (such as Ethernet for wired networks, Wi-Fi for wireless networks, Bluetooth for short-range wireless connections, or a cellular standard for mobile phones)

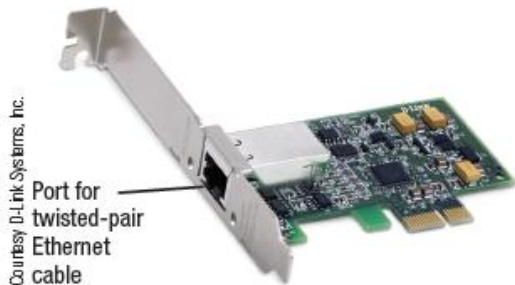
Communications Hardware

- Network Adapters and Modems
 - Network Adapter (network interface card (NIC))
 - Used to connect a computer to a network
 - The type of adapter used depends on the type of network and communications medium being used
 - Modem
 - Used to connect a computer to another computer or to a network (typically the Internet) over phone lines
 - Also used to refer to any device that connects a computer to a broadband Internet connection, i.e., cable modem

Communications Hardware

- Each type of modem matches a particular type of Internet connection (conventional dial-up, cable, fixed wireless, DSL, etc.)
- Both network adapters and modems are available in internal and external versions and in a variety of formats (USB, ExpressCard, etc.)
- Other Networking Hardware
 - Hub, switch, or router
 - Central device used to connect devices in a wired network together

Communications Hardware



PCI EXPRESS GIGABIT ETHERNET ADAPTERS FOR DESKTOP COMPUTERS



USB WI-FI ADAPTERS FOR DESKTOP OR NOTEBOOK COMPUTERS



Incoming coaxial cable from cable provider and either a USB or Ethernet cable coming from the computer or router connect to the back of the modem.



EXPRESSCARD WI-FI ADAPTERS FOR NOTEBOOK COMPUTERS



USB 4G CELLULAR MODEMS FOR DESKTOP OR NOTEBOOK COMPUTERS

FIGURE 2-30
Common types of communications hardware.

Summary

- Input Hardware
- Processing Hardware and Other Hardware Inside the System Unit
- Output Hardware
- Storage Hardware
- Communications Hardware