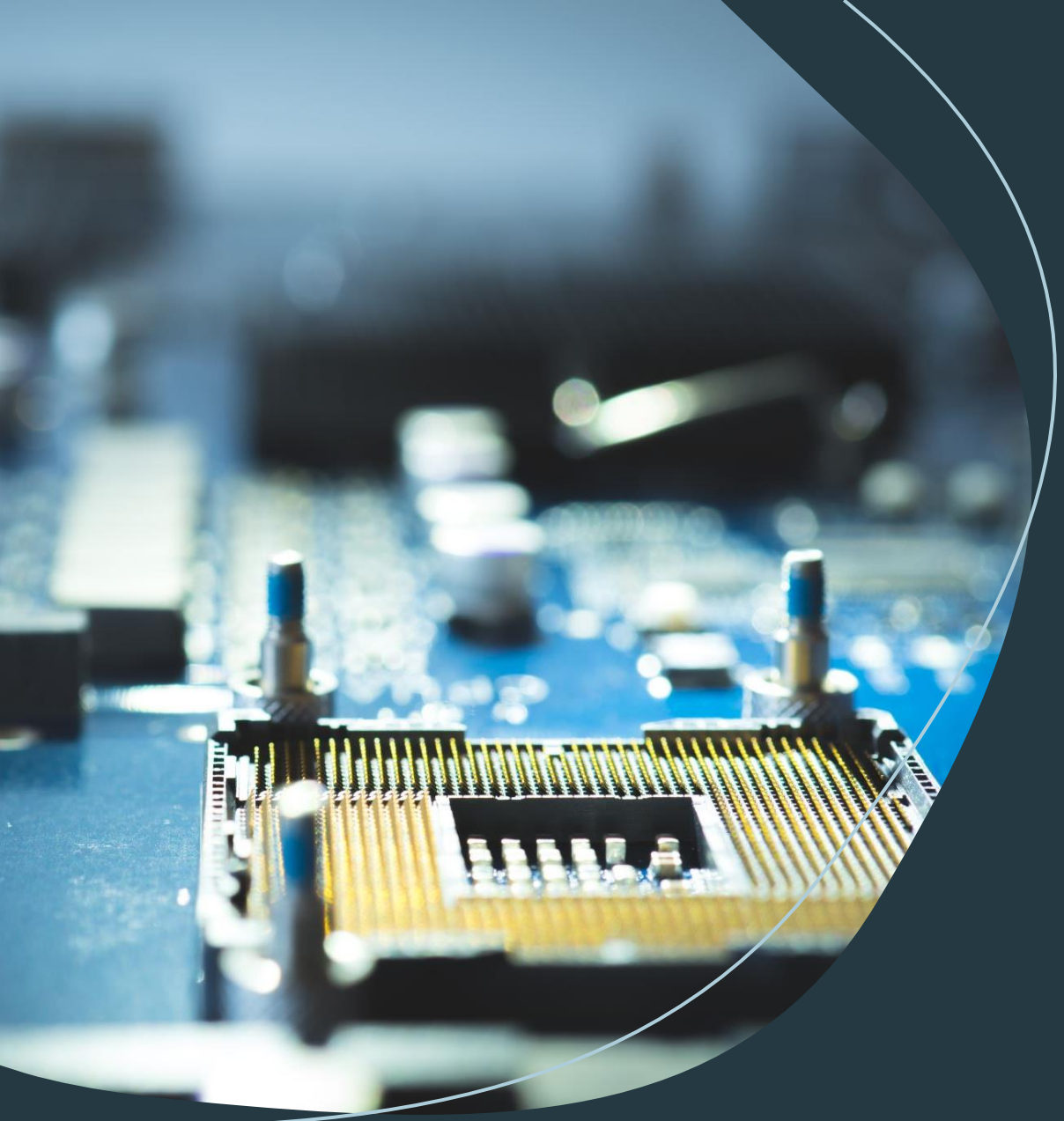
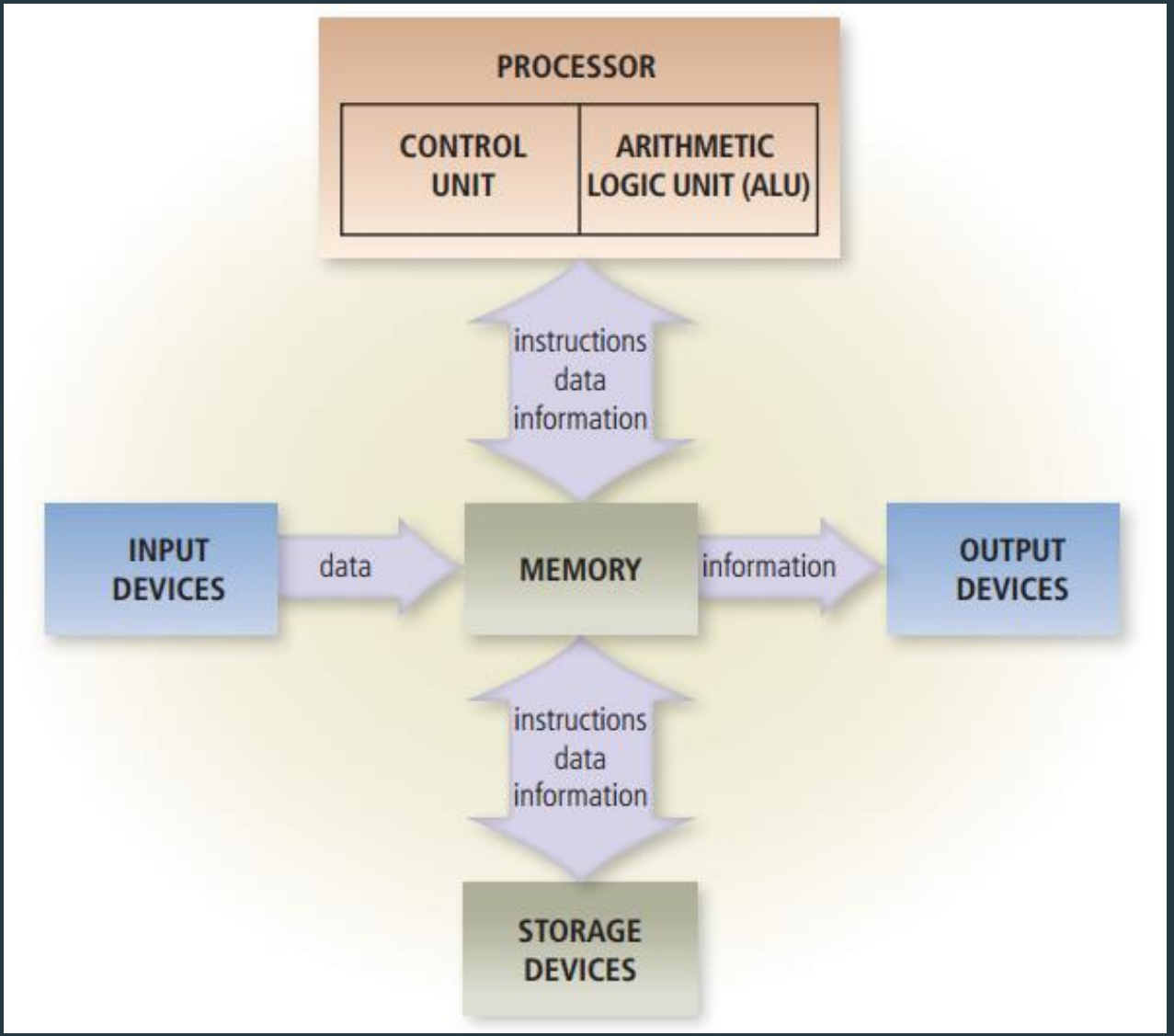


Computer Hardware Components

Recall

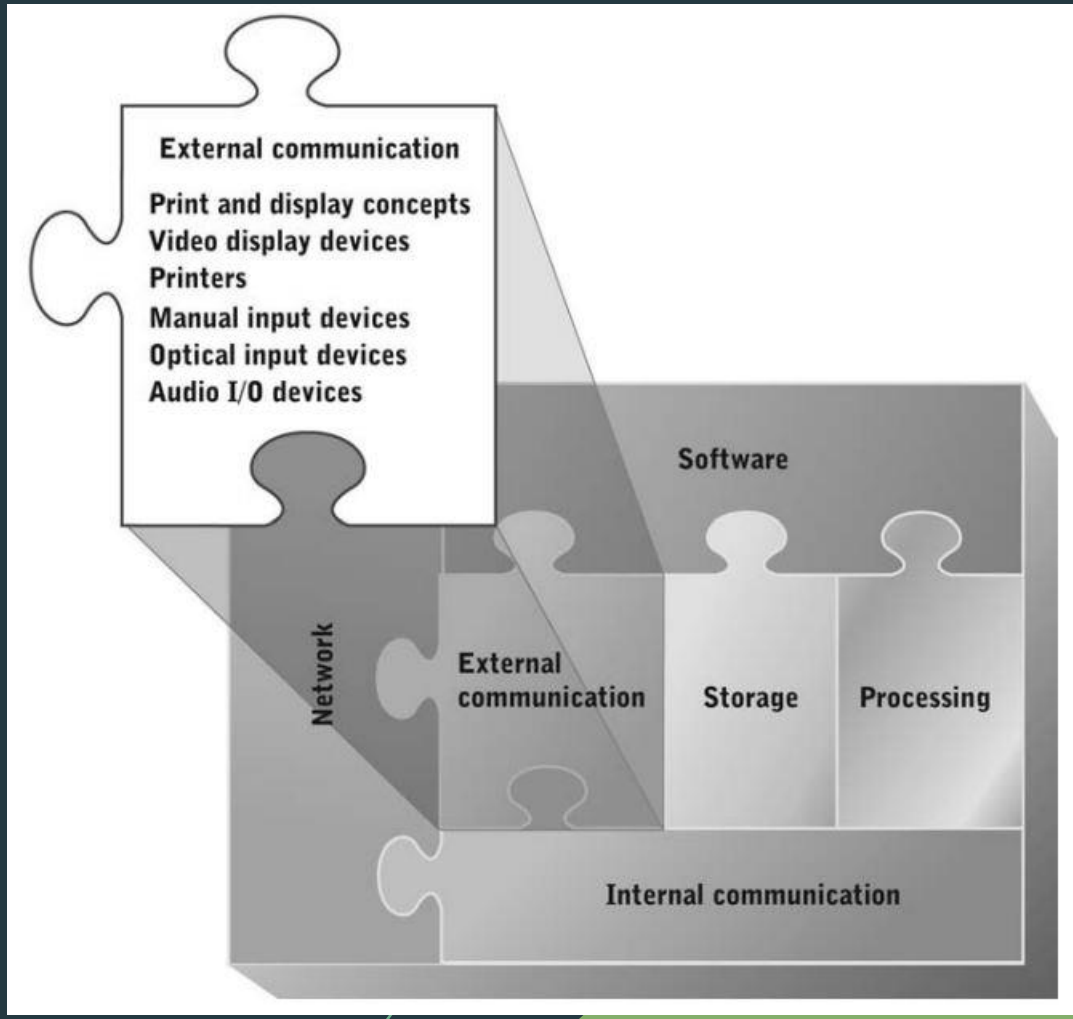
- Storage can be classified into 2 types:
  - Primary storage – ROM/RAM
  - Secondary storage – HDDs/ SSDs/optical drives/cloud
- The CPU accesses RAM to retrieve and store data and program instructions
- Data in RAM can be sourced from input devices and secondary storage; and can be sent to output devices or secondary storage



Input and Output Devices

I/O Technology

- People communicate in many different ways, and these differences are reflected in a variety of methods for interacting with computer systems



Input Devices

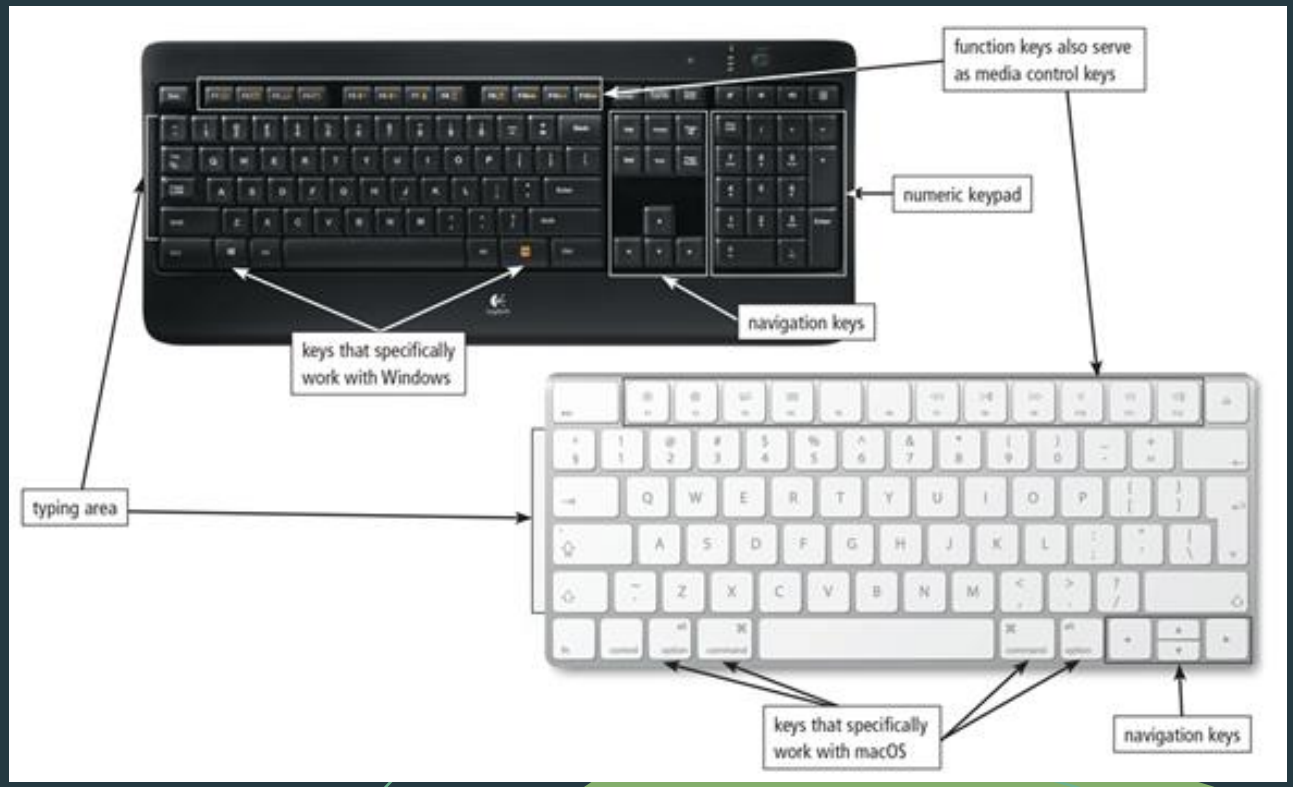
What Is Input?

- **Input** is any data and instructions entered into the memory of a computer

- Commonly used input methods include:
  - Keyboard
  - Pointing devices
  - Touch screens
  - Pen input
  - Motion input
  - Voice input
  - Video input
  - Scanners and reading devices

Keyboards

- A **keyboard** is an input device that contains keys you press to enter data and instructions into a computer or mobile device
- Nearly all keyboards have…
  - Typing area
  - Function keys
  - Toggle key
  - Navigation keys
  - Media control buttons
  - Internet control buttons
  - Other special keys



Keyboards

- Modern keyboard devices translate keystrokes directly into electrical signals
- Pressing a key sends a coded signal to an integrated microprocessor (keyboard controller), and the controller generates a bitstream output (scan codes) according to an internal program or lookup table.

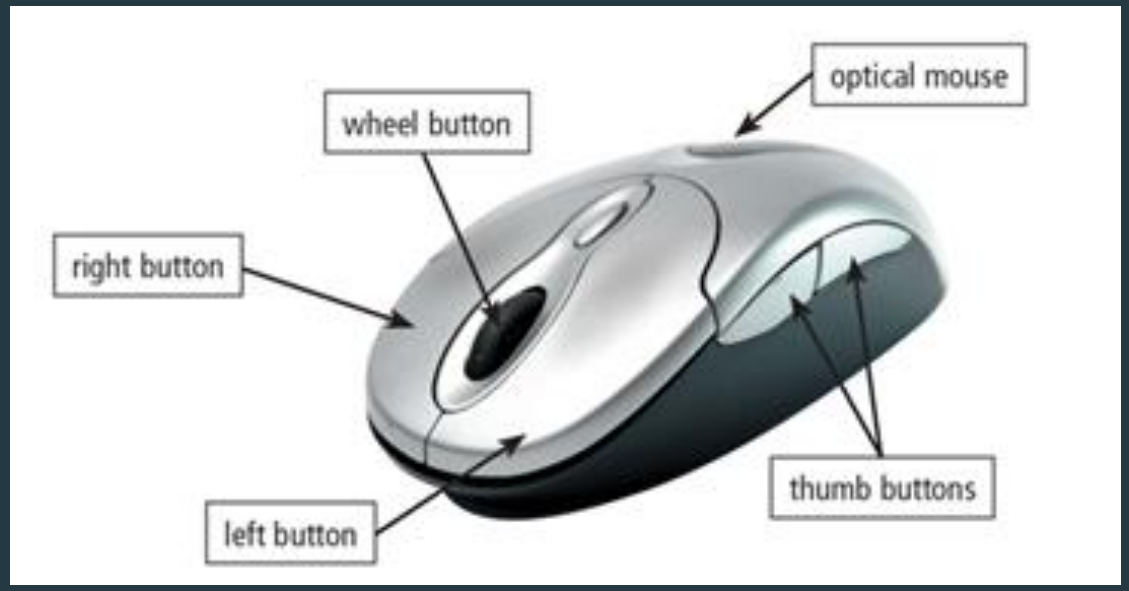
Dome Switch Keyboards Aka 'membrane keyboard'	Mechanical Keyboards
• Uses a thin rubber or silicon layer with individual domes per key that collapse when pressed • Relatively quiet and low cost • Can fail to register keystrokes when not pressed down far enough	• Uses individual switches per key • More expensive • More tactile because keys can register even if pressed halfway

Keyboards

- An ergonomic keyboard has a design that reduces the chance of repetitive strain injuries (RSIs) of wrist and hand
- Ergonomics incorporates comfort, efficiency, and safety in the design of the workplace

Pointing Devices

- **Pointing devices** Translate the spatial position of a pointer or other selection device into numeric values in a system of 2D coordinates to control a cursor.
- **Mouse**
  - Mechanical – use a roller ball to move wheels which specify movement along the X and Y axis
  - Optical - uses an optical scanner that scans the surface under the mouse at a high resolution. A microprocessor in the mouse compares many scans per second to determine the direction and speed of movement.



Pointing Devices

Trackballs – essentially are upside down mechanical mice

Touchpad - small, flat, rectangular pointing device that is sensitive to pressure and motion

Touchscreens

- **Touchscreen** technology enables a flat panel display to function as both an input and output device.
- Additional components and layers are added to an LCD or LED to sense touch by a **stylus**, finger, or multiple fingers

Capacitive Touchscreens	Resistive Touchscreens
Rely on conductivity of objects to sense their location on the screen Generally considered more sensitive and responsive compared to resistive screens	Made up of several layers, the topmost of which relies on pressure to sense the location of objects Generally considered more accurate compared to capacitive screens

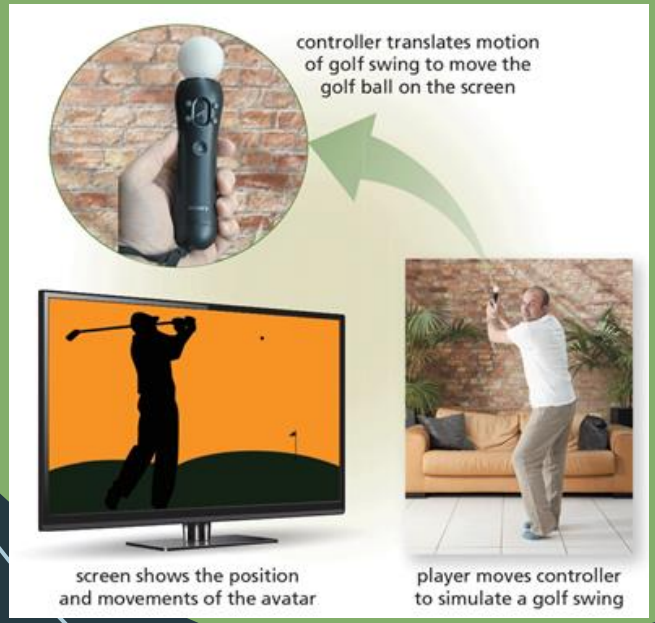
Pen Inputs

- A **graphics tablet**, also called a digitizer, is an electronic plastic board that detects and converts movements of a **stylus** or digital pen into signals that are sent to the computer

Motion Input

With motion input, sometimes called **gesture recognition**, users can guide on-screen elements using air gestures

Commonly rely on gyroscopes, accelerometers and cameras to recognize object position

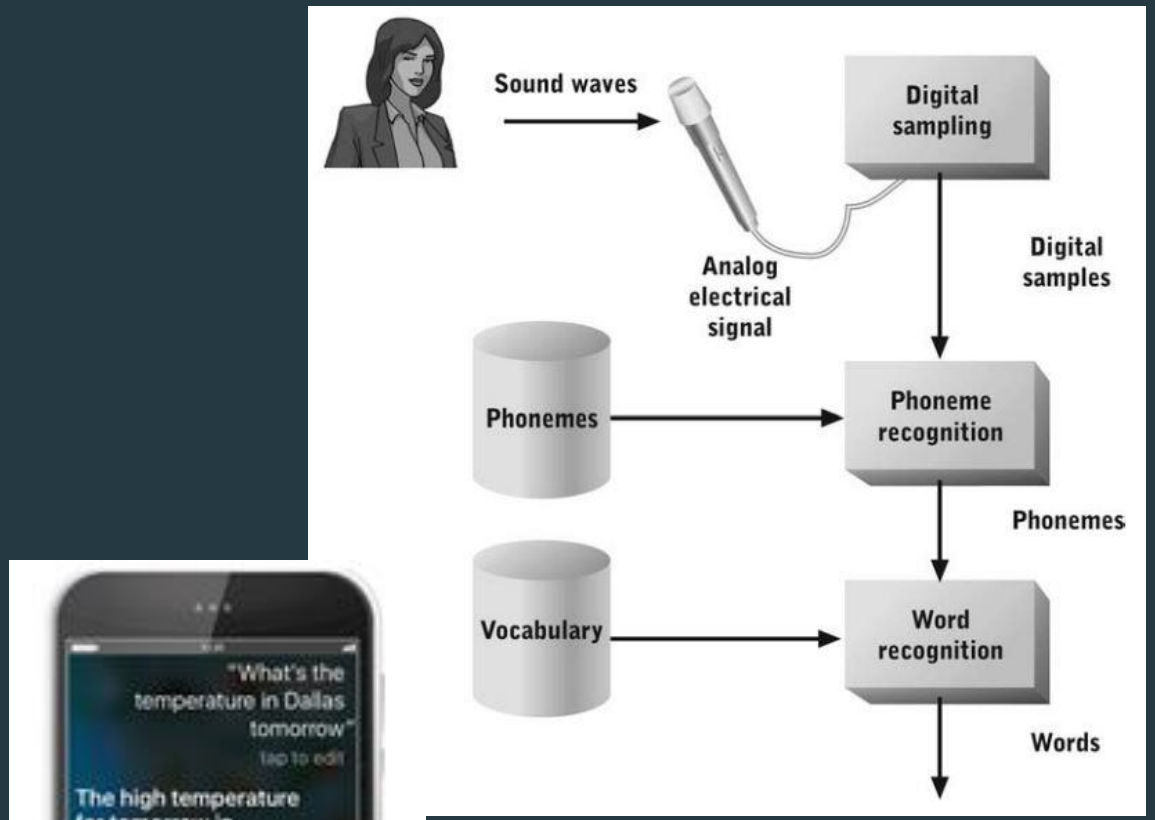


Audio Input

- Audio input is the process of entering any sound into the computer such as speech, music, and sound effects
- Music production software allows users to record, compose, mix, and edit music and sounds

Voice Input

- Voice input is the process of entering input by speaking into a microphone
- **Speech recognition** is the process of recognizing and responding to the meaning embedded in spoken words, phrases, or sentences.



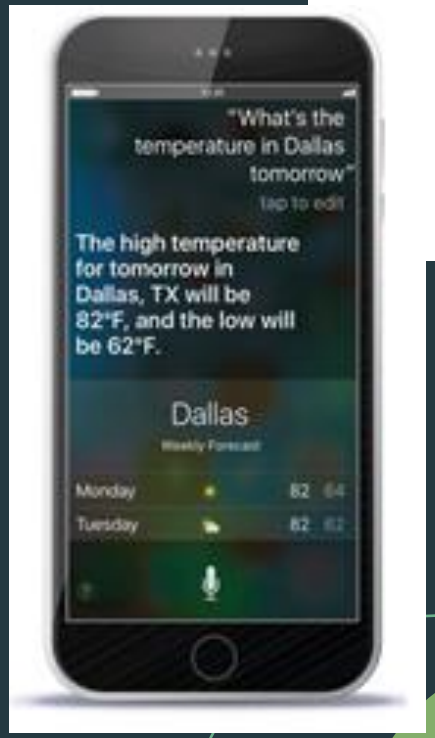


Image Input

- **Image input** is the process of capturing images and storing them on a computer or mobile device's storage medium
- Digital still cameras, video cameras, and Webcams use a 2D photosensor array placed behind lenses to capture reflected and focused ambient light.
- A digital **still camera** samples the photosensor array's output then generates a bitmap when the shutter button is pressed
- Digital **video cameras** capture moving images by rapidly capturing a series of still images (frames) into a buffer.
    - Increasing the number of frames that can be captured per second (fps) improves video quality

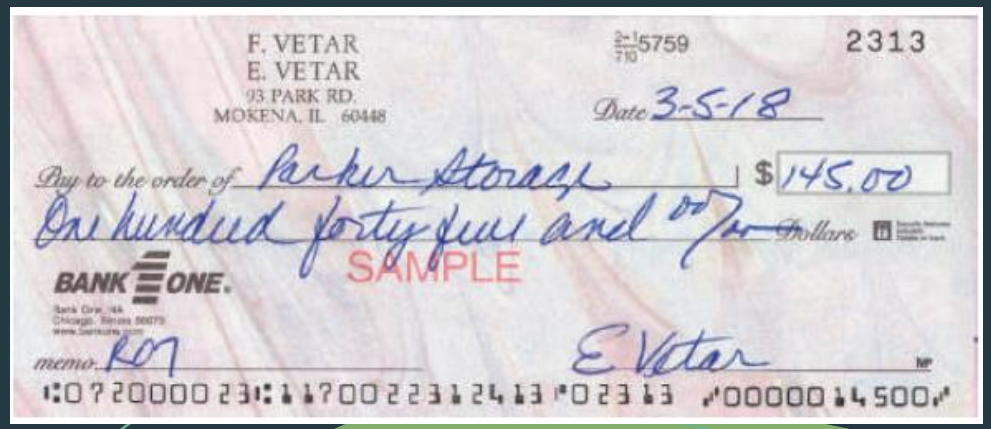
Mark Sensors and Code Scanners

- **Mark sensors / Optical Mark Readers** scan for light or dark marks at specific locations on a page.
  - Input locations are drawn on a page with circles or boxes and are selected by filling them in with a dark markings.
  - Sensor uses preprinted bars on the edge of the page to establish reference points
- **Code Scanners** detects specific patterns of bars or boxes
  - Use **scanning lasers** that sweep a narrow laser beam across a code that follows a standard encoding pattern
  - Encoding can be based on line width and spacing (bar codes), or in patterns of small black and white blocks (2D bar codes and QR codes)

Magnetic Scanners

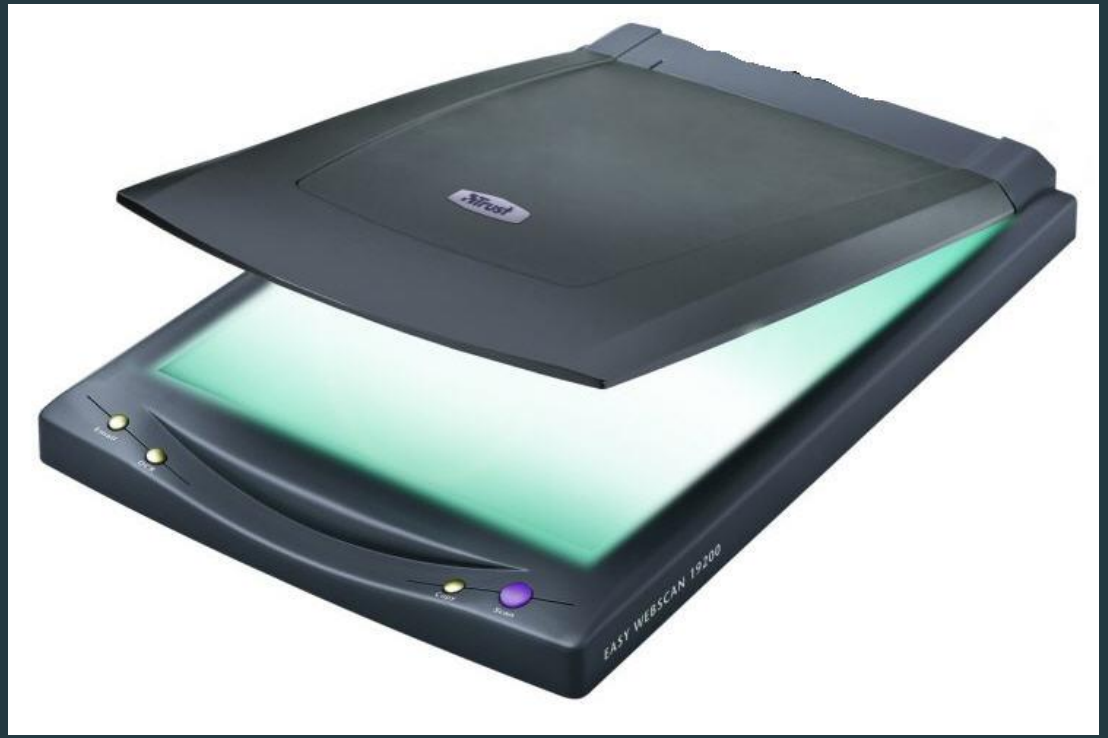
- A **magstripe reader** reads data that is encoded on a magnetic stripe stripe (e.g. back of a credit card)

- **MICR (magnetic ink character recognition)** devices read text printed with magnetized ink and converts them into a form the computer can process



Optical Scanners

- **Optical scanner** generates bitmap representations of printed images.
  - A white light shines on the page or other flat surface
  - Reflected light is detected by an array of photosensors that interpret the color on the scanned image
- **Optical Character Recognition (OCR)** uses a special-purpose processor or software to interpret bitmap content and search for patterns similar to printed characters



Output Devices

What Is Output?

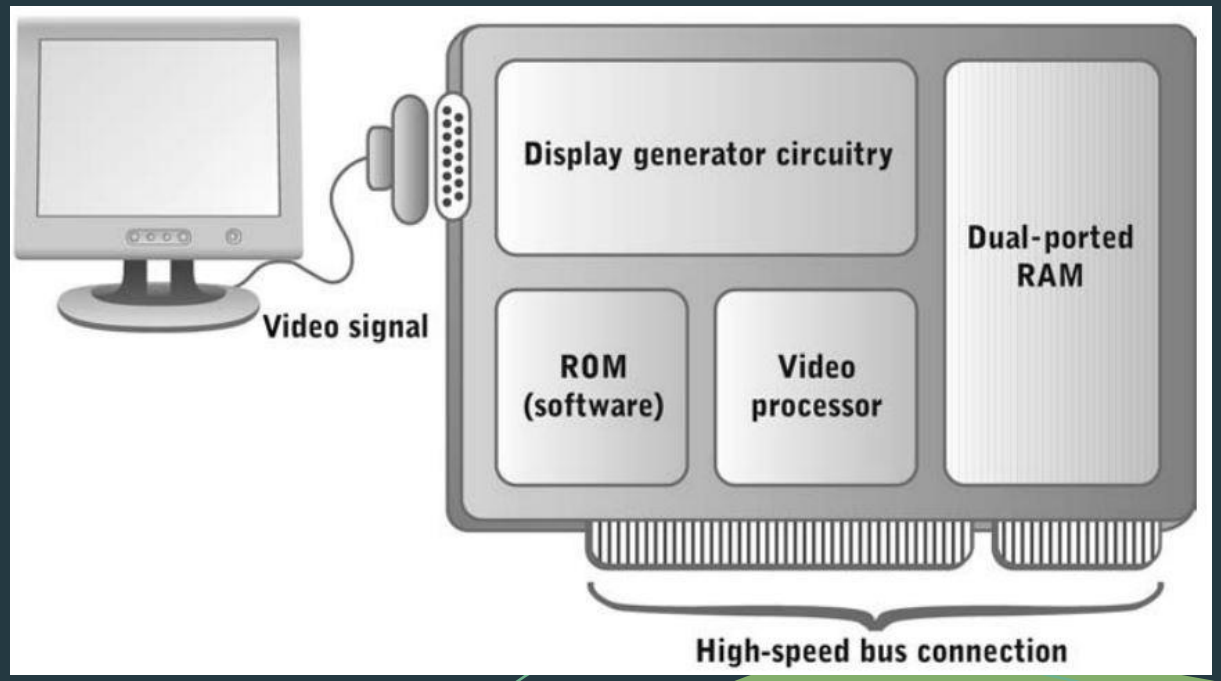
- **Output** is data that has been processed into a useful form and presented to a user in the form of
  - Text
  - Graphics
  - Video
  - Audio

Displays

- A **display** visually conveys text, graphics, and video information
- A **monitor** is a display that is packaged as a separate peripheral device
- The quality of a display depends primarily on its:
  - Resolution
  - Response time
  - Brightness
  - Dot pitch
  - Contrast ratio

Displays

- **Video controllers** accept commands and data from the CPU and memory and generates analog or digital video signals, which are transmitted to a display panel. They can be separate expansion cards that have their own RAM and graphics processor (GPU)
- Displays can be connected to the video controller using a variety of ports
  - VGA
  - DVI
  - HDMI
  - Display Port



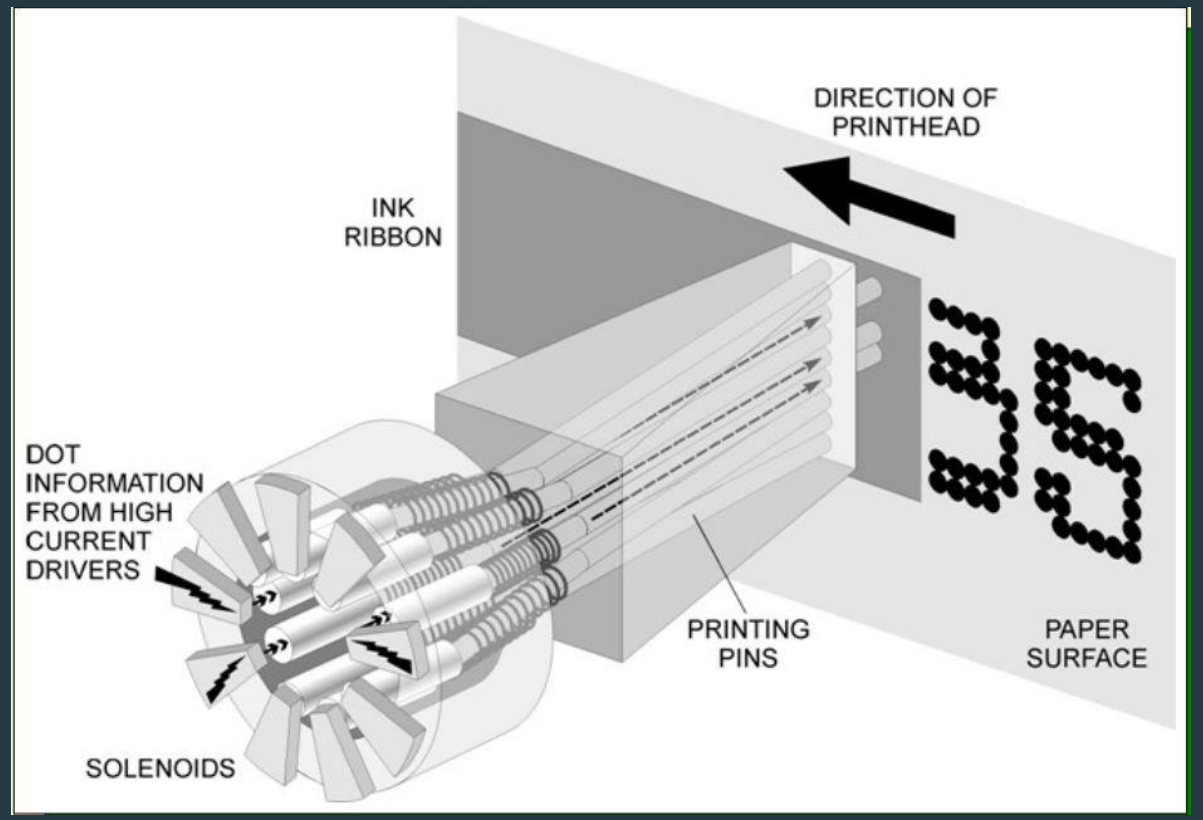
Alternative Displays

- An **interactive whiteboard** is a touch-sensitive device, resembling a dry-erase board, that displays the image on a connected computer screen

A **data projector** is a device that projects the text and images displaying on a computer or mobile device screen on a larger screen so that an audience can see the image clearly

Printers

- A **printer** is an output device that produces text and graphics on a physical medium
- **Impact Printers** make contact with the printing medium to produce text
  - A **dot matrix** printer moves a matrix of pins to press a ribbon soaked with ink over the paper.
  - Commonly still used for high-speed printing of multicopy forms

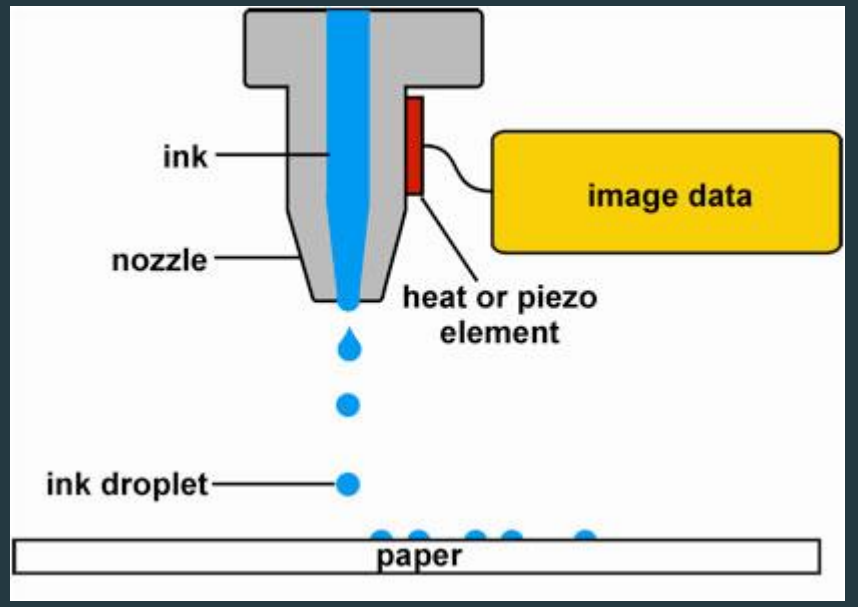


Printers

- A **nonimpact printer** forms characters and graphics on a piece of paper without actually contacting the paper
  - Ink-jet printers
  - Photo printers
  - Laser printers
  - All-in-one printers
  - 3-D printers
  - Thermal printers
  - Mobile printers
  - Label printers
  - Plotters
  - Large-format printers

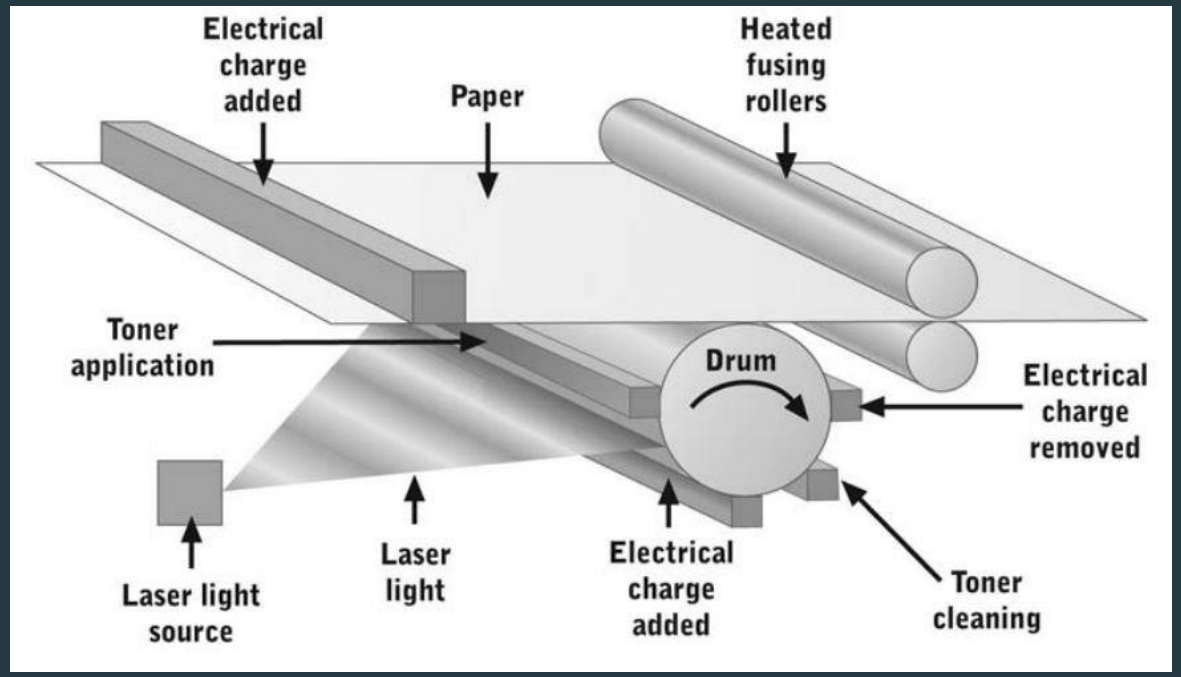
Printers

- **Inkjet printer** places liquid ink directly onto paper.
  - One or more disposable inkjet cartridges containing large ink reservoirs
  - Matrix of ink nozzles that drops ink using mechanical movement or heat
  - Electrical wiring and contact points enable the printer to control the position of the nozzle carriage and the flow of ink through each nozzle



Printers

- A **laser printer** operates with an electrical charge and the attraction of ink to this charge
  - Rotating metal drum is lightly charged with the pattern of the image to be printed on the paper
  - After charging, the drum passes a station where fine particles of toner are attracted to the charged areas.
  - Toner transfers to paper as it passes over the drum

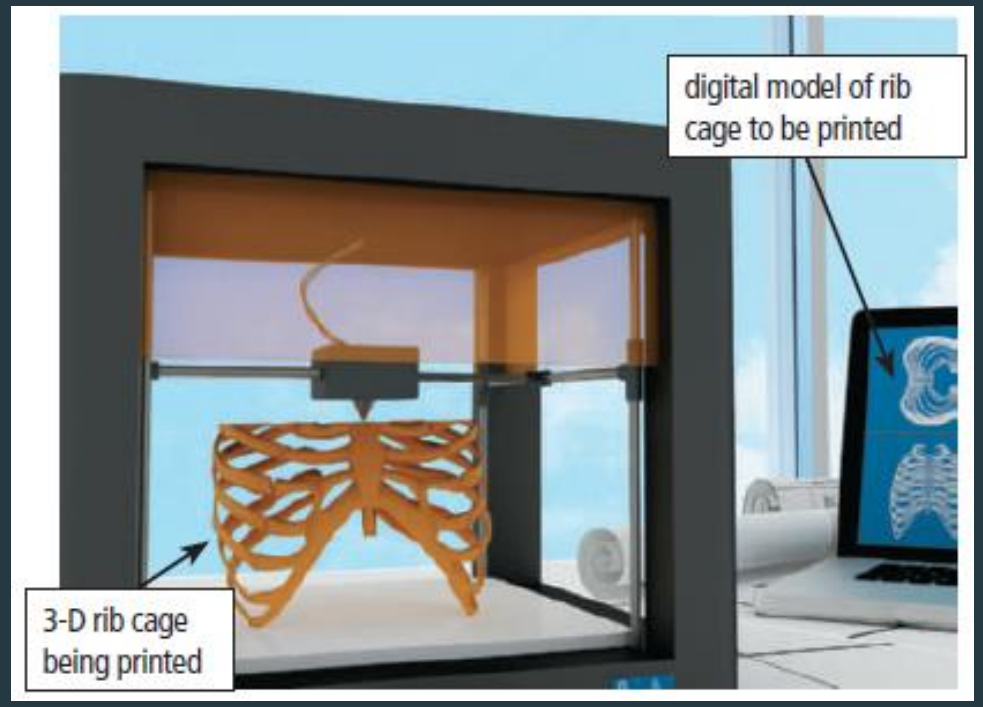


Printers

- A **thermal printer** generates images by pushing electrically heated pins against the heat-sensitive paper
- **Plotters** are used to produce high-quality drawings
- **Large-format printers** create photo-realistic quality color prints

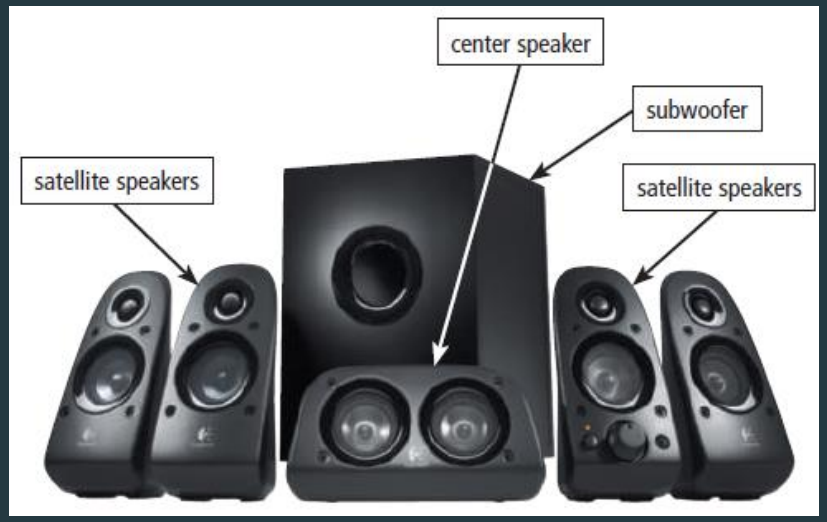
Printers

A **3-D printer** uses a process called additive manufacturing to create an object by adding material to a three-dimensional object, one horizontal layer at a time



Audio Devices

- Audio devices produce sound output from the audio controller of the computer



Assistive Technologies

- Assistive devices facilitate computer access for people with disabilities
- Examples: Braille printers, speech output systems, motion trackers