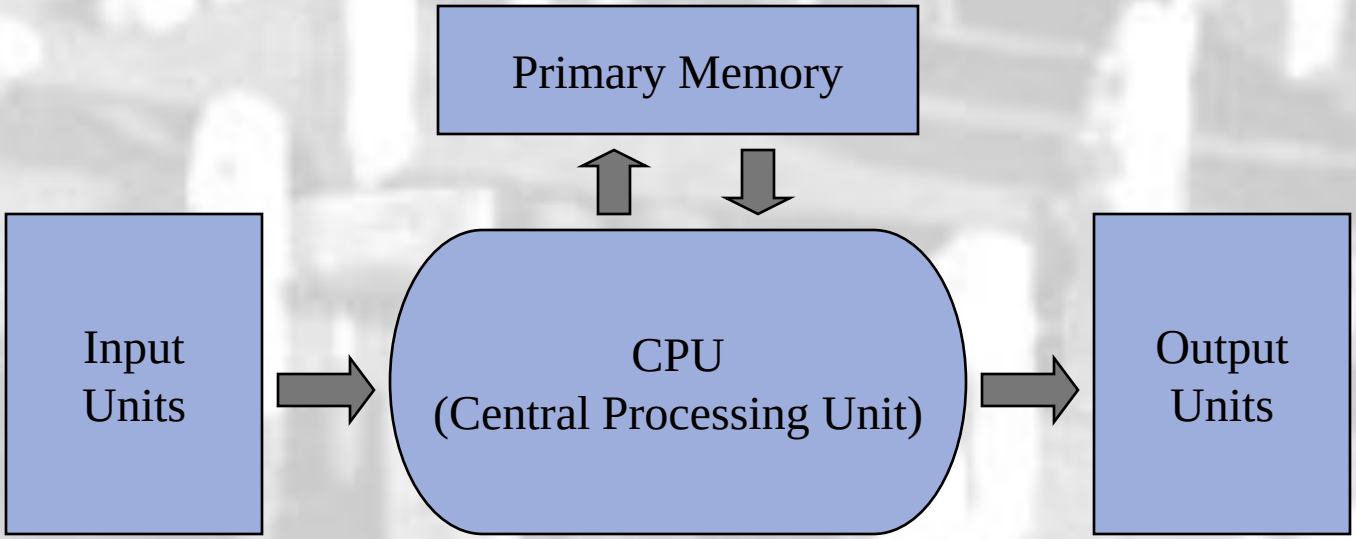
Computer Hardware Components: CPU, Memory, and I/O

Basic Concepts of Computer Hardware



- This model of the typical digital computer is often called the **von Neumann** computer.
  - Programs and data are stored in the same memory: **primary memory.**
  - The computer can only perform one instruction at a time.

Basic Concepts of Computer Hardware

- Input/Output (I/O): Refers to the process of getting information into and out of the computer.
  - Input: Those parts of the computer receiving information to programs.
  - Output: Those parts of the computer that provide results of computation to the person using the computer.

Sources of Data for the Computer

- Two types of data stored within a computer:
  - **Original data** or **information**: Data being introduced to a computing system for the first time.
    - Computers can deal directly with printed text, pictures, sound, and other common types of information.
  - **Previously stored data** or **information**: Data that has already been processed by a computer and is being stored for later use.
    - These are forms of binary data useful only to the computer.
    - Examples: Floppy disks, DVD disks, and music CDs.

Input Devices

- Two categories of input hardware:
  - Those that deal with original data.
  - Those that handle previously stored data.

Input Devices

- Input hardware: Those that deal with original data.
  - Keyboard
  - Mouse
  - Voice recognition hardware
  - Scanner
  - Digital camera
- Digitizing: The process of taking a visual image, or audio recording and converting it to a binary form for the computer.
  - Used as data for programs to display, play or manipulate the digitized data.

Input Devices

- Connecting Hardware to the computer:
  - Hardware needs access through some general input/output connection.
    - **Port**: The pathway for data to go into and out of the computer from external devices such as keyboards.
      - There are many standard ports as well as custom electronic ports designed for special purposes.
      - Ports follow standards that define their use.
        - » SCSI, USB: Multiple peripheral devices (chain).
        - » RS-232, IDE: Individual peripheral devices.
    - **Peripheral device**: A piece of hardware like a printer or disk drive, that is outside the main computer.

Input Devices

- Connecting Hardware to the computer : Hardware needs software on the computer that can service the device.
  - **Device driver**: Software addition to the operating system that will allow the computer to communicate with a particular device.
- Common Basic Technologies for Storing Binary Information:
  - Electronic
  - Magnetic
  - Optical

Input Devices

- Electronic Circuits
  - Most expensive of the three forms for storing binary information.
  - A flip-flop circuit has either one electronic status or the other. It is said to flip-flop from one to the other.
  - Electronic circuits come in two forms:
    - Permanent
    - Non-permanent

Input Devices

- Magnetic Technology
  - Two parts to most of the magnetic forms of information storage:

    - The **medium** that stores the magnetic information.
      - Example: Floppy disk. Tiny spots on the disk are magnetized to represent 0s and 1s.
    - The **device** that can “read” that information from the medium.
      - The drive spins the disk.
      - It has a magnetic sensing arm that moves over the disk.
      - Performs nondestructive reading.

Input Devices

- Optical
  - Uses lasers to “read” the binary information from the medium, usually a disc.
    - Millions of tiny holes are “burned” into the surface of the disc.
    - The holes are interpreted as 1s. The absence of holes are interpreted as 0s.

Input Devices

- Secondary Memory Input Devices
  - These input devices are used by a computer to store information and then to retrieve that information as needed.
    - External to the computer.
    - Commonly consists of floppy disks, hard disk drives, or CD-ROMs.
  - Secondary memory uses binary.
    - The usual measurement is the byte.
      - A byte consists of 8 binary digits (bits). The byte is a standard unit.

Input Devices

- The four most important characteristics of storage devices:
  - Speed and access time
  - Cost / Removable versus non-removable
  - Capacity
  - Type of access

Input Devices

- **Speed** (Access time) - How fast information can be taken from or stored onto the computer memory device's medium.
  - Electronic circuits: Fastest to access.
    - 40 billionths of a second.
  - Floppy disks: Very slow in comparison.
    - Takes up to 1/2 second to reach full speed before access is even possible.

Input Devices

- **Cost**
  - **Megabyte**: A Million bytes.
  - **Gigabyte**: A billion bytes.
  - Two parts to a removable secondary storage device:
    - The cost of the medium. (*Cheaper if bought in quantity)*
    - The cost of the drive.

Examples:	Cost for drive	Cost for medium
Floppy drive (1.4MB)	59.00	.50
Zip 100 (100 MB)	99.00	10.00
CD-WR (650 MB)	360.00 and up	1.00

Input Devices

- **Capacity -** The amount of information that can be stored on the medium.

Unit	***Description***	***Approximate Size***
1 bit	1 binary digit	
1 nibble	4 bits	
1 byte	8 bits	1 character
1 kilobyte	1,024 bytes	≈1/2 page, double spaced
1 megabyte	1,048,576 bytes 1 million bytes	≈500,000 pages
1 gigabyte	1,073,741,824 bytes 1 billion bytes	≈5 million pages
1 terabyte	1 trillion bytes	≈5 billion pages

Input Devices

- **Type of Access**
  - **Sequential -** Obtained by proceeding through the storage medium from the beginning until the designated area is reached (as in magnetic tape).
  - **Random Access -** Direct access (as in floppy and hard disks).

Primary Memory

- **Primary storage** or **memory**: Is where the data and program that are currently in operation or being accessed are stored during use.
  - Consists of electronic circuits: Extremely fast and expensive.
  - Two types:
    - **RAM** (non-permanent)
      - Programs and data can be stored here for the computer's use.
      - Volatile: All information will be lost once the computer shuts down.
    - **ROM** (permanent)
      - Contents do not change.

The Central Processing Unit

- The Central Processing Unit (CPU)
  - Often referred to as the “brain” of the computer.
  - Responsible for controlling all activities of the computer system.
  - The three major components of the CPU are:
    1. **Arithmetic Unit** (Computations performed)
       Accumulator (Results of computations kept here)
    2. **Control Unit** (Has two locations where numbers are kept)
       Instruction Register (Instruction placed here for analysis)
       Program Counter (Which instruction will be performed next?)
    3. **Instruction Decoding Unit** (Decodes the instruction)
  - **Motherboard**: The place where most of the electronics including the CPU are mounted.

Output Devices

- Output units store and display information (calculated results and other messages) for us to see and use.
  - Floppy disk drives and Hard disk drives.
  - Display monitors: Hi-resolution monitors come in two types:
    - **Cathode ray tube** (CRT) - Streams of electrons make phosphors glow on a large vacuum tube.
    - **Liquid crystal display** (LCD) - A flat panel display that uses crystals to let varying amounts of different colored light to pass through it.
      - Developed primarily for portable computers.

Output Devices

- Audio Output Devices
  - Windows machines need special audio card for audio output.
  - Macintosh has audio playback built in.
  - Audio output is useful for:
    - Music
      - CD player is a computer.
      - Most personal computers have CD players that can access both music CDs and CD-ROMs.
    - Voice synthesis (becoming more human sounding.)
    - Multimedia
    - Specialized tasks (i.e.: elevator's floor announcements)

Output Devices

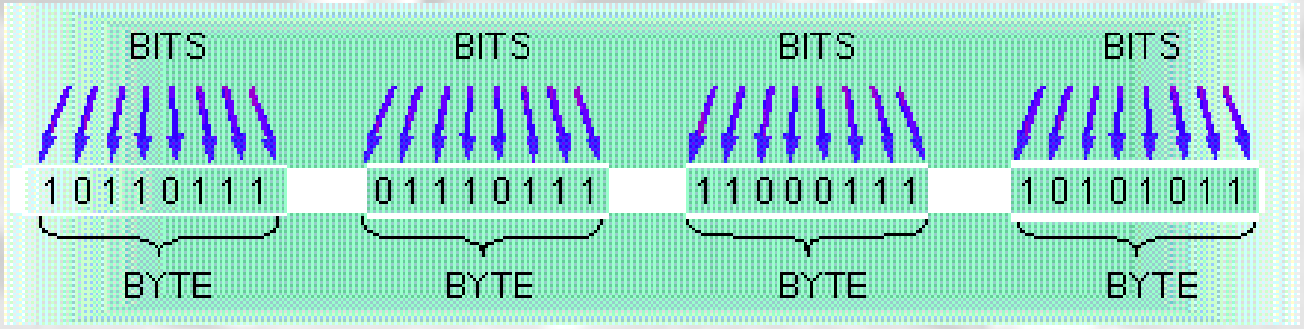
- Optical Disks: CD-ROM and DVD
  - CD-ROM (Compact Disk - Read Only Memory)
    - By its definition, CD-ROM is Read Only.
    - Special CD drives “burn” information into blank CDs.
      - Burn: A laser is used to “burn” craters into the surface to represent a binary 1.
      - Two main types of CDs:
        - » CD-R (Compact Disk - Recordable)
        - » CD-WR (Compact Disk - ReWritable)
    - It takes longer to write to a CD-R than a hard drive.
    - Special software is needed to record.

Output Devices

- Storage Requirements: How much storage capacity is needed for…
  - One keystroke on a keyboard. — 1 byte (8 bits)
  - One page single-spaced document. — 4.0 K
  - Nineteen pages formatted text. — 75 K
  - One second of high-fidelity sound. — 95-110 K
  - Complete word processing program. — 8.4 MG
- Storage Capacity: How much data can be stored on…
  - One inch of 1/2 in. wide magnetic tape. — 4 K
  - One 3 1/2” floppy disk, high density. — 1.4 MG
  - One Compact Disk. — 650 MG
  - One DVD. — up to 17 GB

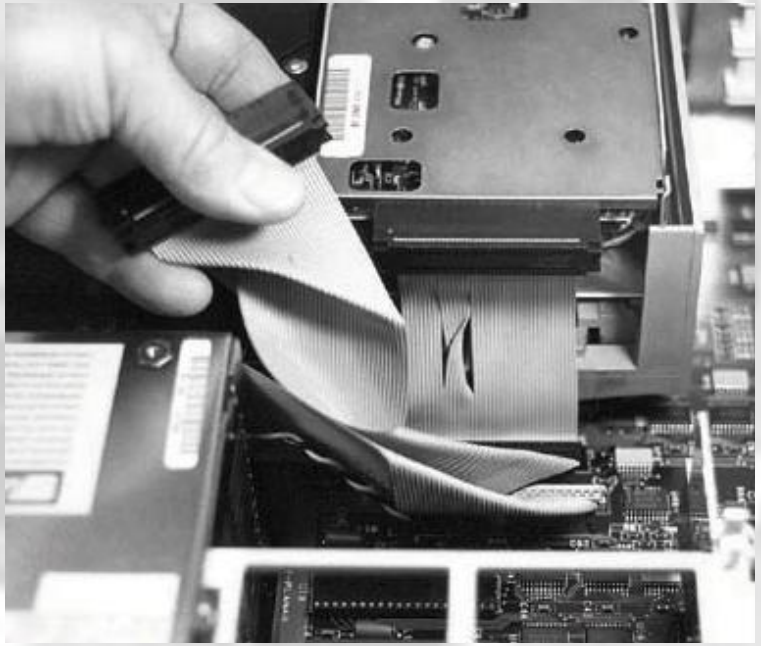
Moving Information Within the Computer

- Information is moved about in bytes, or multiple bytes called words.
  - **Words** are the fundamental units of information.
  - The number of bits per word may vary per computer.
  - A word length for most large IBM computers is 32 bits:



Moving Information Within the Computer

- Bits that compose a word are passed in parallel from place to place.
  - **Ribbon cables**:
    - Consist of several wires, molded together.
    - One wire for each bit of the word or byte.
    - Additional wires coordinate the activity of moving information.
    - Each wire sends information in the form of a **voltage pulse.**



Software Tools for Maintaining Your Computer Hardware

- **Utility Programs** exist that can help diagnose and solve computer hardware problems.
  - Four major problem areas where utility programs are helpful:
    - Finding and fixing problems.
      - Testing Input/Output peripherals.
      - Testing RAM, motherboard, video cards.
      - Recovering deleted files or fixing damaged disks.
    - Improving computer performance.
      - De-fragmenting a disk (Packs all files closer together).
    - Preventative maintenance.
    - Troubleshooting.
      - Locates incompatible programs.