CHAPTER THREE: Computer System

Objective:

- What a computer system is and how it works to process data

3.1. Introduction

System is a group of components, consisting of subsystems or procedures that work in a coordination fashion to achieve some objective.

A **Computer System** is composed of components that are classified either as ***Computer hardware*** or ***Computer software***.

3.2. Computer Hardware

Computer architecture is defined as the science of selecting and interconnecting hardware components to create computers that meet functional, performance, and cost goals. It can be described as the logical structure of the computer system.

Computer hardware is the physical part of the computer that can be touched, seen, broken.

What a computer in general does is, that

- It takes input (in various forms)
- Process it (according to a given set of instructions) and
- Produce an output (in required form).
- Store the information

Based on this the hardware part of a computer system is composed of a number of interacting physical parts. The different hardware parts of a computer which are responsible for these operations are illustrated by the following model.

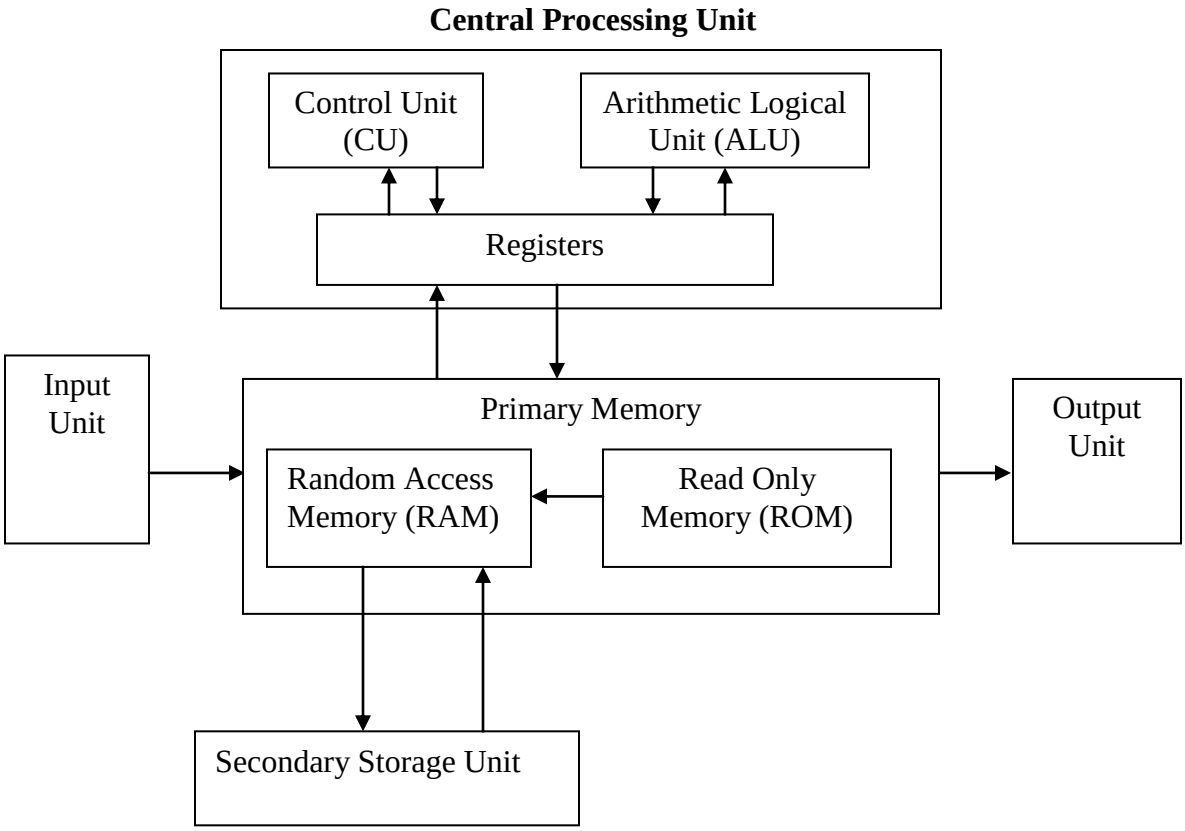


Fig 3.1 Information flow in the computer hardware

3.2.1. The Central Processing Unit (CPU)

The **CPU** or the **microprocessor** (or simply processor) is referred as the brain of the computer system; it is a VLSI chip inside the system, plugged onto the motherboard. A processor controls all internal and external devices, and performs arithmetic and logical operations. It is the most costly and main component of the computer system.

A processor operates only on binary data, that is, data composed of 1s and 0s. These 1s and 0s correspond to electrical switches being switched ON or switched OFF.

The processor performs, supervises, and controls the arithmetic and logic functions. It performs arithmetic operations such as additions, multiplication, division, and logical operations such as 'is A greater than B'?

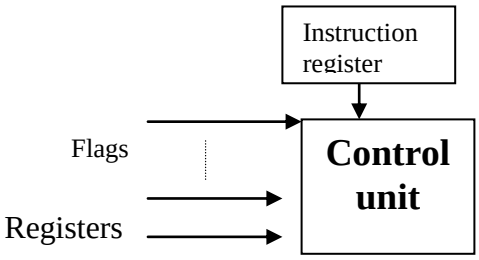
The functions of a processor can be summed up as:

- ✓ Carrying out arithmetic and logical operations

- ✓ Controlling the use of main storage (memory) to store data and instructions
- ✓ Controlling the sequence of operations
- ✓ Controlling all the parts of the computer system

The CPU consists of three main subsystems: The ***control unit (CU),*** **the** ***Arithmetic Logic Unit (ALU),*** and the ***Registers***. The three subsystems work together to provide the operational capabilities of the computer.

- ❖ **Purpose of CPU**
  - ✓ Fetch instruction: The CPU read instruction from the memory
  - ✓ Interpret instruction: the instruction must be decoded to determine what action is required
  - ✓ Fetch data: the execution of an instruction may require reading of data from memory or an I/O module.
  - ✓ Process data: the execution of an instruction may require performing some arithmetic or logical operation on data.
  - ✓ Write data: The result of an execution may require writing data to memory or an I/O module.
- ❖ **The Control Unit**



- ➢ Controls the flow of information.
- ➢ As the name implies, it performs all the control functions of the computer.
- ➢ It retrieves the instruction from memory.
- ➢ Translates those instructions into computer functions and sends signals to other computer hardware units to carry out those functions.
- ➢ It is also responsible for determining the next instruction to be executed by the computer.
- ➢ In general it serves as the computer traffic cope.

❖ **The Arithmetic Logical Unit (ALU)**



- It is referred as the computers "number crunchier ".
- It performs the arithmetic calculations: addition, subtraction, multiplication, division and comparisons (and, or, xor) and it is used to keep track of and execute instruction.
- All modern digital computers can do is addition;
  - multiplication is merely a continuous addition;
  - subtraction is the addition of the complements of the number to be subtracted;
  - Division is the addition of complements.

❖ **Registers**

The registers are special purpose, high speed memory units. They hold various types of information such as data, instructions, addresses, and the intermediate results of calculations. Especially, they hold the information that the CPU is currently working on.

Registers can be thought of as CPU's working memory. As soon as a particular instruction or piece of data is processed, the next instruction immediately replaces it, and the information that results from the processing is returned to main memory (RAM). Data and instructions do not enter either the ALU or the CU, instead the ALU work on the data held in the registers along with the instruction on which it acts.

Instruction addresses are normally stored in consecutive registers and are executed sequentially. The control unit reads an instruction in the memory by a specific address in the register and executes it. The next instruction is then fetched from the sequence and executed, and so on. This type of instruction sequencing is possible only if there is a counter to calculate the address of the

instruction after instruction. This counter is a register, which stores intermediate data used during the execution of the instructions after it is read from the memory.

The important registers within the CPU are:

Register Name	**Function**
Program Counter (PC)	A program counter keeps track of next instruction to be executed
Instruction Register (IR)	Holds the instruction to be decoded by the control unit
Memory Address Register (MAR)	Holds address of the next location in memory to be accessed
Memory Buffer Register (MBR)	Is used for storing data either coming to the CPU or data being transferred by the CPU
Accumulator (ACC)	It is a general-purpose register used for storing temporary results and results produced by arithmetic logic unit
Data Register (DR)	Is used for storing the operands and other data.

- **CPU Characteristics**

1. Machine Cycle time

- The time in which a machine cycle occurs is measured in fractions of seconds. The machine cycle time ranges from milliseconds to Pico seconds. Machine cycle time can also be measured in terms of how many instruction are executed in one second usually millions of instructions per second (MIPS)

2. Clock Speed

- CPU produces a series of electronic pulses at a predetermined rate, called **clock Speed**, which affects machine cycle time. **System clock** is a circuit that generates electronic pulses at a fixed rate to synchronize processing activities.
- One cycle or pulse is known as a hertz (HZ). Normally, megahertz (MHZ) or giga hertz (GHZ) is the measurement of cycles in millions per second.

3. World Length and Bus Line Width

- Data is moved in computer system in groups of bits. A bit is a Binary digit 0 or 1.
- The number of bits the CPU can process at one time, called the word length of the CPU, determines overall system performance.
- A CPU with word length of 32 (called 32 bit CPU) will process 32 bits of data in one machine cycle.
- Data is transferred from the CPU to the other system components or vice versa via Bus Line.
- Bus line is the physical wiring that connects the computer system components and transfers data between them. The number of bit a bus line can transfer at any one time is the bus line width.

3.2.2. Storage Units

Storage units are used to store data. There are two types of storage units: *Primary and Secondary*.

3.2.2.1. Primary Storage

The ***primary memory*** or the ***main memory*** is part of the main computer system. The processor directly stores and retrieves information from it. The processor accesses the main memory in random fashion, that is, the processor can access any location of this memory either to read information from it or store information in it.

The primary memory is implemented by two types of memory technologies. The first is called ***Random Access Memory (RAM)*** and the other is ***Read Only Memory (ROM)***.

3.2.2.1.1. Random Access Memory (RAM)

RAM can be defined as a block of sequential memory locations, each of which has a unique address determining the location and those locations contain a data element. It stores programs and data that are in active use.

Storage locations in main memory are addressed directly by the CPU's instructions. It is volatile in nature, which means the information stored in it remains as long as the power is switched ON. As soon as the power is switched OFF, the information contained in it vanishes.

RAM can be further divided into two categories:

1. **Dynamic RAM (DRAM)**: - This type of RAM holds the data in dynamic manner with the help of a refresh circuitry. Each second or even less than that the content of each memory cell is read and reading action refreshes the contents of the memory. Due to this refreshing action, the memory is called DRAM.

2. **Static RAM (SRAM)**: - SRAM along with DRAM is essential for a system to run optimally, because it is very fast as compared to DRAM. It is effective because most programs access the same data repeatedly and keeping all this information in the fast SRAM allows the computer to avoid accessing the slower DRAM. SRAM is generally included in a computer system by the name of cache.

Cache: - It is a piece of very fast memory, made from high-speed static RAM that reduces the access time of the data. It is very expensive and generally incorporated in the processor, where valuable data and program segments are kept. This enables the processor to access data quickly whenever it is needed.

Major reason for incorporating cache in the system is that the CPU is much faster than the DRAM and needs a place to store information that can be accessed rapidly.

The cache facilitates the system to catch up with the processor's speed. The cache fetches the frequently used data from the DRAM, and buffers (stores) it for further processor usage.

Cache can be further categorized into two categories:

- **Level 1 Cache (L1)**: - It, also known as primary cache, is built into the processor chip. It is a small fast memory area that works together with the Level 2 cache to provide the processor much faster access to important and often used data.
- **Level 2 Cache (L2)**: It, also known as secondary cache, is a collection of static RAM chips that are built onto the motherboard. L2 cache is a little larger and slower than L1, but is faster than the main memory. L1 and L2 cache are used together for optimal use of processor.

3.2.2.1.2. Read Only Memory (ROM)

As the name suggests, read only memory can only be read, not written. In other words, CPU can only read from any location in the ROM but cannot write. The contents of ROM are not lost even in case of a sudden power failure, making it

non-volatile in nature. The instructions in ROM are built into the electronic circuits of the chip. These instructions are called *firmware*. ROM is also random access in nature.

❖ Types of ROM

- ***Masked ROM***: It is a hard-wired device that contained a pre-programmed set of data or instructions. The contents of such ROMs have to be specified before chip production, so the actual data could be used to arrange the transistors inside the chip.
- ***Programmable ROM (PROM)***: Blank PROM chips can be coded by anyone with a special tool such as PROM-Programmers. However, once a PROM has been programmed, its contents can never be changed. It is also known as one-time programmable (OTP) device. Like other ROMs, the information stored in PROM is also non-volatile, but they are more fragile that other ROMs as a jolt of static electricity can easily cause fuses in the PROM to burn out, changing essential bit pattern from 1 to 0.
- ***Erasable Programmable ROM (EPROM)***: It is programmed in exactly the same manner as a PROM. However, unlike PROMs, it can be erased and reprogrammed repeatedly. An EPROM can be erased by simply exposing the device to a strong source of ultraviolet light for certain amount of time. An EPROM eraser is not selective; it will erase the entire EPROM.
- ***Electrically Erasable Programmable ROM (EEPROM)***: It can be erased by an electrical charge and then written to by using slightly higher-than-normal voltage. It can be erased one byte at a time. Hence, the process of re-programming is flexible, but slow. It is often used to store programmable instructions in devices, such as printers and other peripherals.
- ***Flash ROM***: Also called Flash BIOS or Flash memory, is a type of constantly powered non-volatile memory that can be erased and re-programmed in blocks. It is often used to hold control code such as the BIOS in a personal computer. It is used in Digital cellular phones, digital cameras, LAN switches, PC Cards for notebook computers, digital set-up boxes, embedded controllers, and other devices.

3.2.2.2. Secondary Storage units

Secondary Storage: - Secondary storage or auxiliary storage, can take many forms, which have traditionally included punched cards, papers tape, magnetic tape, magnetic disk, floppies, and CD-ROMs.

The information in the secondary storage device can be accessed, depending upon how the information is stored on the storage medium. Primarily, there are two methods of accessing data from the secondary storage devices:

- **Sequential**: - Sequential access means the computer system must search the storage device from the beginning until it finds the required piece of data. The most common sequential access storage device would be a magnetic tape where data is stored sequentially and can be processed only sequentially. This access method is less expensive than other methods. The disadvantage of sequential organization is that searching for data is slow.

- **Direct**: - Direct access, also known as random access, means that the computer can go directly to the information that the user wants. The most common direct access storage is the disk and the most popular types of disks today are magnetic and optical disks.

3.2.2.2.1. Sequential Access Media

- ***Punched Cards***

Punched cards are one of the oldest and most familiar forms of data storage. There are two types of punched cards, 80 – columns, and 96 – columns and the first one is a standard punched card. Using one card we can represent 80 characters.

  - If only a numeric punch is in any column, it represents whatever number is punched out.

- ***Punched Paper Tape***

Punched paper tape is a continuous strip of paper used to store data in much the same manner as punched cards. The paper tape is approximately one inch wide & can have either six or eight channels. Eight channels paper tape is based on the ASCII code. This storage media is less expensive and more compact than punched cards.

- ***Magnetic Tapes***

Magnetic tapes are a particularly popular form of secondary storage because of their high data density (the number of bytes of instruction per inch of tape) and their convenience in handling. Magnetic tapes are approximately one - half inch wide and are made of Mylar – based plastic film which can be magnetized. Data are stored on a magnetic tape by running the tape over the electromagnetic called read/write head which magnetizes small spots on the tape. Seven-track tapes store information as bytes of information, where each byte consists of a six-bit code and a one-bit parity bit. Nine-track tape uses an eight-bit and a parity bit.

An 800 bytes per inch density of magnetic tape and has a length of 100 inch can store 80,000 bytes of information.

3.2.2.2.2. Direct (Random) Access Media

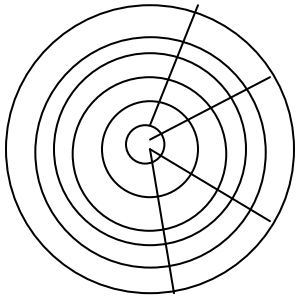
- ***Magnetic disks***

Magnetic disks are metals or plastic platters coated with ferrous oxide, an easily magnetizable material. Magnetic disks allow for random access of information and overcome the slow access time commonly found in tape files.

- ***Floppy disks***

  - ✓ Also called diskette.
  - ✓ Used to store programs and data for a longer period outside the computer system.
  - ✓ Often used with mini and micro computers.

- ✓ Data is stored in concentric circles called ***tracks***.
- ✓ Each track is further divided into sectors
- ✓ A sector stores the amount of information that can be read or written in single operation.



Disk drive: - is part of a computer system which reads from and writes data on a disk.

- ***Hard Disk***

- ✓ A high capacity magnetic disk made up of metal which can be fixed in the system unit of the computer.
- ✓ Serves as a secondary storage.
- ✓ Enables very fast accessibility of data.
- ✓ Accessing data from hard disk is faster than from floppy disks.
- ✓ The disks, which are usually grouped together into a *disk pack*, are separated by small air spaces to allow access for read/write head.
- ✓ Each disk has approximately 200 tracks on which information is stored. Tracks of the small number on all adjacent disks are referred to as a *cylinder* of that disk.
- ✓ The disk pack is mounted on a magnetic disk drive which rotates the disk at speed up to 1,000 revolutions per second.
- ✓ Cross section of a disk pack
- ✓ The total collection of tracks available on one movement of the access mechanism is known as *cylinder.*
- ✓ The amount of time it takes to retrieve (or store) data from (or to) disk is called the disk access time.

3.2.3. Input/output units

Input/Output units allow people and other technologies to put data into a computer and get information out of a computer.

3.2.3.1. Input Unit

- Is the unit used to enter data into the computer so that it can be processed.
- It converts information from a form suitable to human beings to one understandable by the computer.

Examples of input devices;

- Keyboard (which is the most widely used input devices)
- Disk derives (floppy and hard-disk derives)
- Mouse, trackball, joystick
- Scanner
- Light pen (a photo cell to choose a displayed response to request further information).
- Voice synthesizer;
- CD-ROM Drive, etc.

3.2.3.2. Output Unit

Output is anything that comes out of a computer. The output may be a picture, text or image. An output device is any machine capable of accepting and representing information from a computer.

An output unit converts the result of the only-machine understandable form to a form understandable by human beings.

Examples

- The Visual Display Unit (VDU) or monitor or screen
- Printers (dot matrix, desk wheel, laser printers)
- Plotters
- Voice (audio) response unit, Disk drives

❖ **Types of Output Devices**

1. **Hard Copy**: The physical form of output is known as *hard copy*. In general, it refers to the recorded information copied from a computer onto paper or some other durable surface, such as microfilm. Hard copy output is permanent and relatively stable form of output. This type of output is also highly portable. Paper is one of the most widely used hard copy output media. Among the wide variety of hard copy output devices, the following are the most commonly used ones.
    a. Printers
    b. Plotters
    c. Microfilm

2. **Soft Copy**: The electronic version of an output, which usually resides in computer memory and/or on disk, is known as *soft copy*. It is not permanent form of output. It is transient and is usually displayed on the screen. This kind of output is not tangible, that is, it cannot be touched. Soft copy output includes audio and visual form of output, which is generated using a computer. In addition, textual or graphical information displayed on a computer monitor is also a soft copy form of output. Among the wide variety of hard copy output devices, the following are the most commonly used ones.
    a. Monitors
    b. Audio response
    c. Projectors

❖ Hard Copy Output Devices

A. Printers

The most common output device you will encounter will be the printer. Printer is available in various forms, to suit the needs of various types of users. A printer is an output device that prints characters, symbols, and perhaps graphics on paper hardcopy.

Printers are categorized according to whether or not the image produced is formed by physical contact of the print mechanism with the paper. Hence they classified as *impact* and *non-impact printers*. Impact printers have contact; non-impact printers do not.

1. Impact Printers

These types of printers form images by striking a mechanism such as a print hammer or wheel against an inked ribbon, leaving an image on paper like a typewriter. Impact printers are dying out, though you might still run across a dot-matrix printer.

Characteristics of Impact printers:

- There is physical contact with the paper to produce an image
- Relatively low consumable(ink, ribbon, etc) costs
- Useful for bulky printing
- Very noisy
- Since they are mechanical in nature, they tend to slow

Impact printers include:

- Dot matrix Printers
- Daisy Wheel Printers
- Drum Printers

❖ Dot matrix printer

- It is the oldest printing technology and it prints one character at a time.
- It can print any shape of character, which a user can specify.
- The speed of dot matrix printers is measured in ***characters per second (cps).*** The speed can vary from about 200 to over 500 cps.
- The print quality is determined by the number of pins (the mechanisms that print the dots), which can vary from 9 to 24.
- Most dot matrix printers have a resolution ranging from 72 – 360 dpi (dot per inch).
- Dot matrix printers are inexpensive and have low operating costs.

- The major limitation of dot matrix printer is that it prints only in black and white.
- The image printing ability is also very limited.

❖ Daisy Wheel Printers

- They can produce professional letter quality documents.
- These printers are commonly referred to as letter quality printers as the print quality is as good as that of a high-quality typewriter.
- They produce high-resolution output and are more reliable than dot matrix printers.
- They can have speeds up to 90 cps.
- These printers give only alphanumeric output. They cannot print graphics and cannot change fonts unless the print wheel is physically replaced.
- They are slower and more expensive than dot matrix printers.

❖ Drum Printers

- Drum printers can print an entire line in a single operation. Hence, these printers are known as *line printers*.
- Their printing speed varies from 150 lines to 2500 lines per minute with 96 to 160 characters on a 15-inch line.
- Have limited multi-font capability, and often produce lower print quality than most recent printing technologies.
- Line printers are designed for heavy printing applications. They are very expensive.

2. Non-impact Printers

Non-impact printers are faster and quieter than impact printers, and you find them almost everywhere these days. Non-impact printers form characters and images without direct physical contact between the printing mechanism and the paper. Two types of non-impact printers often used with microcomputers are:

❖ Laser printers

- A laser printer creates images with dots. However, these images are created on a drum treated with magnetically charged ink-like toner (powder), and then transferred from drum to paper.
- Laser printers produce resolutions at near-typeset quality;
- Color printing is available in more expensive models.
- Laser printers also have built-in RAM chips to store documents;
- Built-in ROM chips to store fonts and other formatting; and their own small, dedicated processor.
- Provide high speed and capabilities
- A toner, a black granular dust, is used in the process
- Prints up to 17 page per minute.

❖ Ink Jet Printers

- Ink-jet printers also form images with dots they spray small, electrically charged droplets of ink from four nozzles through holes in a matrix at high speed onto paper.

- Ink-jets can print in color; they are cheaper and quieter than laser printers; but they are slower and print in a somewhat lower resolution than laser printers.

B. Plotters

A plotter is a specialized output device designed to produce high-quality graphics in a variety of colors. Plotters are used for creating large hardcopy items, such as maps, architectural drawings, and 3-D illustrations items typically too large for regular printers.

C. Microfilm

It is an extremely high speed, low cost process, which records computer generated information directly from the computer tape or cartridge to a

miniaturized microfilm media. The microfilm product is in fiche or roll format, which can be duplicated rapidly and inexpensively. This process can produce data in microfilm form at a highly significant speed from that of a paper printer.

❖ Soft Copy Output Devices

A. Visual Displays (Monitors)

Monitors display softcopy output. Monitors run under the control of a graphics display adapter card plugged into an expansion slot on the system board. The adapter allows information to leave the computer and appear on the monitor.

The Monitor can be:-

➢ Cathode-Ray Tubes (CRTs)

- The cathode-ray tube (CRT) is a vacuum tube used as a display screen in a computer or video display terminal.
- CRTs are the most common softcopy output devices used with desktop computers;
- The CRT's screen display is made up of small picture elements called ***pixels***. A pixel is the smallest unit on the screen that can be turned on or off or made different shades.

➢ Flat-Panel Displays

- Compared to CRTs, flat-panel displays are much thinner, weigh less, and consume less power.
- Their biggest limitations are:
    - ✓ Cost an LCD (Liquid-crystal display) for a desktop microcomputer costs 2-3 times as much as an equivalent CRT monitor;
    - ✓ Images are not always as good as CRT images; and
    - ✓ Flat-panel images cannot be clearly viewed from an angle.

- ✓ Flat-panel displays consist of two plates of glass separated by a substance that may be activated in particular ways.

Monitor, ***display screen***, ***Video Display Terminal*** (VDT) is alternatively used to refer to the screen of the computer. The term "monitor" usually refers to the entire box, where as display screen can mean only the screen. Monitors/VDTs differ in size, color, resolution, bit mapping, refresh rate and graphic standard.

- **Size**

Monitors come in many different sizes from the small screen built in to palm tops and laptop to external large monitors. The standard monitor for personal computers is 13 to 17 inch (32.5 to 42.5 cm) measured diagonally.

- **Color**

Basically, considering color, monitors are grouped into two: *monochrome display* and *color display*. ***Monochrome displays*** actually display two colors: one for background, and one for foreground. These monitors show information using a single foreground color on a contrasting background color. For example, white on black, green on black or vise-versa

The ***color monitor*** display many different colors. Many monitor display color combining shades of red, green, and blue (RGB). These RGB displays or monitors can create 256 colors and other several variations on them by blending shades of red, green and blue (hence they are called "RGB" Displays).

- **Resolution**

On the computer screen, all characters and images are produced as the result of combining dot patterns, which are also, called *pixels*. The number of these dots or pixel per one-inch space (abbreviated as DPL) on the screen determines the quality or sharpness (resolution) of the character or the image. That means, the higher the number of pixels on one-inch space, the quality of the image will be. Common or standard resolutions are:

- 640 columns X 480 rows of dots (307,200 pixels on the full screen)

- 800 columns X 600 rows (480,000 pixels)
- 1,024 columns X 768 rows (786,432 pixels)

➢ **Refresh Rate**

- Refresh rate is the number of times per second the pixels are recharged so that their glow remains bright.

➢ **Graphics Standard**

- It is related to resolution; graphics standards combine resolution and use of color.

- A computer monitor is used with a graphics adapter card, an interface board between computer and monitor that performs one of severally used IBM compatible standards: color graphics adapter (CGA, the oldest and lowest resolution standard); enhanced graphics adapter (EGA), Video graphics array (VGA), and super VGA (SVGA which has the best resolution of all).

There are different standards for monitors, and they support different color depths.

❖ **VGA (Video Graphic Array)**

VGA, for video graphics array, will support 16 to 256 colors depending on the resolution. At 320 x 200 pixels it will support 256 colors; at the sharper resolution of 640 x 480 pixels it will support 16 colors, which is called 4-bit color.

❖ **SVGA (Super Video Graphic Array)**

SVGA, for super video graphics array, will support 256 colors at higher resolution than VGA. SVGA has two graphics modes: 800 x 600 pixels and 1024 x 768. SVGA is called 8-bit color. Most new computers offer SVGA.

- **XGA (Extended Video Graphic Array)**

Also referred to as high-resolution display, XGA, for extended graphics array, supports up to 16.7 million colors at a resolution of 1024 x 768 pixels. Depending on the video display adapter memory chip, XGA will support 256, 65,536, or 16, 777,216 colors. At its highest quality, XGA is called 24-bit color, or true color.

Note: Hard Disk Drive and Floppy Disk Drive are a special type of input and output devices.

3.2.4. The bus system

Interconnecting Components in a Computer and Information Movement in a Computer System.

We have seen that there are different components of a computer and each performs a specific function. But to perform a given task in synchronized form there should be some mechanism of communication. For this reason there is an electronic circuit which produces communication path between the different components of a computer system along which data are transferred, that is **Bus.**

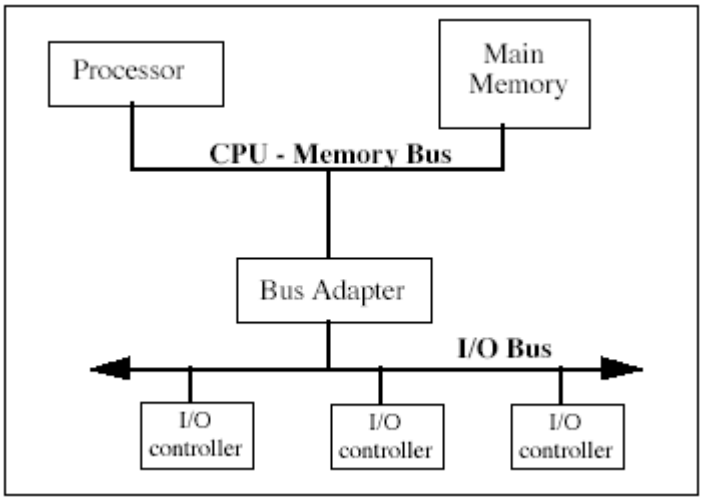
The bus, which communicates the different parts of the CPU, is called ***Internal Bus***. And the bus, which communicates the CPU with memory and peripheral devices, is called ***External Bus***. The size of the bus determines the speed of efficiency of the computer.

Address Bus: - is a unidirectional bus over which digital information is transferred to identify either a particular memory location or particular I/O address.

Data Bus: - a bus system which interconnects the CPU, memory and all the peripheral Input / Output devices of a computer system for the purpose of exchanging data.

Control Bus: - a bus used to select and enable an area of main storage and transmit signals required to regulate the computer operation. It carries control signals that allow the CPU to control the transfer of information along the bus. For example, the CPU must be able to indicate whether information is to be transferred from memory or to memory; it must be able to signal when to start the transfer and so on.

It is important to realize that a computer system may have a number of separate bus systems so that information can be transferred between more than one pair of components at the same time. For example, it is common to have one bus for communicating between memory and the CPU at high speeds. This bus is called a CPU-memory bus. In addition, this bus would be connected to a second I/O bus via a bus adapter, as illustrated in the figure shown below. This second bus would be used for the slower I/O devices.



This arrangement allows the processor more efficient access to memory, as the CPU-memory bus can operate at very high speeds. These high speeds are only possible, if the physical bus length is quite short. Thus, by providing a second I/O bus to accommodate the various I/O devices that may be connected to the computer, the length of the CPU-memory bus can be kept shorter than it would be if the I/O devices were to be directly attached to a single system bus. On the other hand, to keep the cost of a computer system low, a single bus running at a slower speed, may be used to connect all devices to the CPU.

In order to attach any device to a computer, it must be connected to the computer's bus system. This means that we need a unit that connects the device to the bus. The terms device **controller** and device **interface** are used to refer to such a unit. So, for example, a disk controller would be used to connect a disk drive to the system bus and the term I/O controller refers to the controller for any I/O device to be connected to the bus system. A computer system will have some standard interfaces such as a **serial interface**, which can be used with a number of different I/O devices. The serial interface, for example, can be used to attach a printer, a mouse or a modem (device for communications over a telephone line) to the computer. So, if you wish to construct a new type of I/O device, you could use the standard laid down for the serial interface (the RS-232 standard) and you could then attach your device to the computer, using the serial interface.

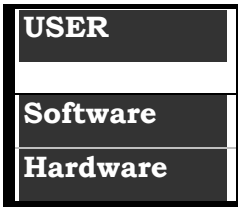
3.3. Computer Software

The computer hardware is an electronic device which has the potential of performing the task of solving a problem. However one has to give precise instructions to the hardware in order to solve problem.

The finite set of instructions (steps) that the computer follow to perform a given job is called a ***program***.

Any program to be executed first it should reside / loaded/ in the memory.

Software:- is a collection of programs and routines that support the operations of performing a task using a computer. Software also includes documentations, rules and operational procedures. Software makes the interface between the user and the electronic components of the computer.



Computer software is classified into two

1. System software
2. Application software

3.3.1. System Software

- ✓ Constitutes those programs which facilitate the work of the computer hardware.
- ✓ It organizes and manages the machine's resources, handles the input/output devices.
- ✓ It controls the hardware by performing functions that users shouldn't have to or are unable to handle.
- ✓ System programs make complex hardware more user friendly.

- ✓ It acts as intermediate between the user and the hardware.
- ✓ It enables the computer understand programming languages i.e. it serves as means of communication between user and a computer.

The important categories of system software are:

A. Operating system
B. Language software

A. Operating system

Operating system coordinates the activity between the user and the computer. An operating system has three major functions.

i. Controlling operations (control program)

- ✓ Coordinates, or supervises the activity of the computer system.
- ✓ Decides where programs and data should be stored in the computer memory.
- ✓ Handles communications among the computer components, applications software and the user.
- ✓ Controls the saving and retrieving of files to and from disks in the disk drive.
- ✓ It performs all its controlling tasks without the involvement or awareness of the user.

ii. Input/output Management

- ✓ The I/O manager coordinates the computers communication with outside world, flow of data to the display screen and other output devices (printers/ plotters) and from the key board or other input devices.
- ✓ Handles the flow of data to and from the disk drives (file management).
- ✓ Handles the process of preparing a disk for use, the copying, renaming, erasing task of a file.

iii. Command Processing (command Interpreter)

- ✓ It interprets the commands or what you enter using the keyboard or other input devices.
- ✓ If you write an internal command it carries out the function of that

command if it is external command or other executable file it searches for the corresponding file in the default (current disk) or the user specified disk, loads the file into memory and transfers control to that program. Once this program is terminated, control returns to command and the program for that command or file is discarded from memory.

❖ ***Types of Operating Systems***

Operating systems can be classified by:

- The number of programs they can handle at a time and
- The number of users they serve at once at one or different stations (i.e. terminals or micro-computers connected to a central computer).

i. Single tasking operating systems

- ✓ With single tasking operating systems: only one program can be run on a computer at a time.
- ✓ In order to run another program, one must remove the first program loaded in the computers main memory and load the other one(i.e. it can't handle two or more programs at a time)
- ✓ These types of operating systems are single user or can serve only one user at a time.

ii. Multi user operating system

- ✓ It supports a number of work stations connected to a central system.
- ✓ A number of users can use the resources of one high capacity computer by the help of terminals.

iii. Real Time Operating System

- ✓ A real time is a system that is capable of processing data so quickly that the results are available to influence the activity currently taking place.
- ✓ Its primary characteristics is that it responds to an event within a well defined time.
- ✓ Example: - Air plane seat reservations and computer controlled plant.

B. Language Software

- It is software which is used by programmers to develop application software's and translates programs to machine code.
- Language software is a generic name consisting of various programs that serve as editors & translators to develop programs in a number of programming languages.
- ***Translator***: - is a program that converts one or more languages to another language. Three types of translators are Assemblers, Compilers & interpreters.
    - ***Assemblers***: - is a program that translates assembly languages into machine code.
    - ***Compiler***: - is a program that translates a high level language into machine code. (Pascal, Fortran Cobol)
    - ***Interpreter***: - is a program that translates each instruction of high level language & executes the instruction before translating the next instruction.
    - ♦ The general-purpose routine and utilities include programs which are used to handle file processing, editing and debugging.
    - ♦ High level language software are software which have their own compilers to detect syntax errors of the users program code.

Example Cobol, Fortran, Pascal. Etc.

There are different types of language software and each of them briefly discussed in the following sections.

❖ **Machine Language (Low-Level Language)**

- ✓ Consists of strings of binary numbers (0s and 1s) and is the only language that the CPU directly "understands".
- ✓ It is referred to as a low level language because the programmer has to think about the type of instructions that a particular machine can execute and know the binary equivalent of the instruction set.
- ✓ Each computer design has its own unique machine codes

Advantage

- Machine Languages make efficient use of memory

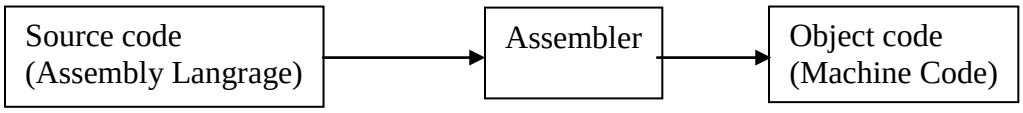
- Instructions of a machine language program are immediately executable.
- Machine language instructions can be used to manipulate the individual bits in a byte of computer storage.

Disadvantage

- Difficult to learn
- Prone to errors
- Difficult to correct or modify errors
- Not portable
- Machine Languages are machine dependent
- Machine languages require a high level of programming skill.

❖ **Assembly Language**

- ✓ Assembly language is a bit higher than machine language, but it is still 'low'. This language lies between high-level languages and machine languages.
- ✓ It's easier for programmers to write instructions in an assembly language than to prepare instructions in machine language codes.
- ✓ An assembler is a program that enables the computer to convert the programmer's assembly language instructions into its own machine code.



- ✓ It is machine dependent. It is not portable from one machine to another.
- ✓ It uses symbolic codes (mnemonic) instead of binary digits
- ✓ A mnemonic code is usually a strict abbreviation of the words it stands e.g. Add for Addition, SUB for subtraction, etc
- ✓ It is still used to write disk drive programs

Advantage

- Writing in Assembly Language saves time and reduces the need for detail.
- Fewer errors are made and those made are easier to find. These programs are easier to modify.
- Easier to learn
- Easier to locate correct errors

Disadvantage

- Coding is time consuming. It is also machine-oriented program. The programmers must know the machine characteristics and requirements
- The program size is big like machine codes
- It is usually unique to a particular computer series
- It is not directly executable by the computer. It needs assembler to translate it into machine codes

❖ High Level Programming Language

The high level programming languages are problem oriented unlike the machine language, which is machine oriented programming language.

The high level languages are symbolic languages that use English like words and/or mathematical symbols rather than mnemonic codes.

A programmer may not be needed to know the details of the internal logical structure of a computer. Some of the Common High Level Languages: FORTRAN, COBOL, PASCAL, C, C++, Java, etc.

Advantage

- Easier to learn and write the codes
- Codes are written with out any particular machine in mind
- Portable
- Small program size
- These languages may be used with different makes of computers with little modifications.
- They are easier to learn.
- They require less time to write.

Disadvantage

- Require more time to run and more computer memory space
- Cannot access all components of the computer hardware such computer accessories. In that case we have to use lower level languages
- They require additional time during translation
- They are less efficient compared to the machine code languages.

3.3.2. Application Software

- Is software that is designed to perform tasks for the specific area or areas. But for use in more than one installation.
- Are usually called application packages as they may include a number of programs along with operating instruction, documentation and so forth.
- Depending on their function or task they are categorized in to the following.

1. **Word Processors/ Word processing**
   - is a computerized typewriter which permits the electronic creation, editing, formatting, filing and printing text.
   - Is the most common application of microcomputers.
   - Until recently, word processing could be done only dedicated word processors. A dedicated word processor is a computer that denies its users the opportunity to execute any other program.

     Example: WordStar, WordPerfect, Microsoft word
2. **Spreadsheet**
   - is an electronic worksheet display on the VDU.
   - Until recently, financial analysis and other mathematical calculation were done by entering numbers on pages of an accountants ruled ledger pad.
   - You can quickly create a model of a situation on a spreadsheet by entering labels, numbers & formulas.
   - Using the programs built-in function you can perform complicated calculations such as net percent value, internal rates of return, and monthly payments on a loan.

     Example: Lotus 1-2-3, Microsoft Excel, Quatropro
3. **Database management system.**
   - Allow you to store information on a computer, retrieve it when you need it and update it when necessary.
   - You can do this with index cards, but database management programs do them more quickly and easily.
   - Example: You can store large mailing list, inventory record or billing and

collect information in lists stored in files and manipulate this information, one file at a time with database management program.

- You can record or create a database about employee information as

  Name, sex,Marital status, salary, Date of Birth, Date of employment, Post, Department, Level of education, Field of study, etc.

Then you can ask the computer the following question

- How many female workers are there?
- List employees with a salary of birr 500 and above
- List those employees who are department head and have Bachelor degree or higher and so on.

Example: Dbase IV, FoxPro, Microsoft Access.