BIM

Semester: I

Foundation of Information technology

Computer System Hardware

Reference Note

Unit-3: Computer System Hardware

Introduction

A computer is more than a high-powered collection of electronic devices performing a variety of information processing chores. A computer is a system, an interrelated combination of components that performs the basic system functions of input, processing, output, storage, and control, thus providing end users with a powerful information processing tool.

Computer Hardware: The physical parts of a computer which can be seen, felt and touched are called computer hardware. Computer hardware is important component of computer system. The user can perform a task by using a set of instructions through the computer hardware. So, the combination of computer hardware and software makes up a full functioning computer system that performs specific task. Motherboard, microprocessor, RAM, ROM, hard disk, pen drive, keyboard, scanner, monitor, etc. are the examples of computer hardware.

Computer architecture: Computer architecture is a specification detailing how a set of software and hardware technology standards interact to form a computer system or

platform. In short, computer architecture refers to how a computer system is designed and what technologies it is compatible with.

➢ Computer Architecture is the conceptual design and fundamental operational structure of computer system.

➢ It also includes the overall fundamental working principle of the internal logical structure of a computer system.

Computer peripherals, which are devices such as a keyboard, electronic mouse, trackball, or stylus for the input of data and commands, a video screen or printer for the output of information, and magnetic or optical disk drives for the storage of data resources.

Computer System

Computer systems, which consist of central processing units containing microprocessors and a variety of interconnected peripheral devices such as printers, scanners, monitors, and so on.

A computer system refers to the fully functional system that is integration of both hardware and software. The hardware components of a computer of a computer system are physical components that are tangible such as keyboard, mouse, processor, mother board, main memory, secondary memory, monitor, printer, etc. whereas the software components are logical components that make physical component work such as data, information, computer instructions etc.
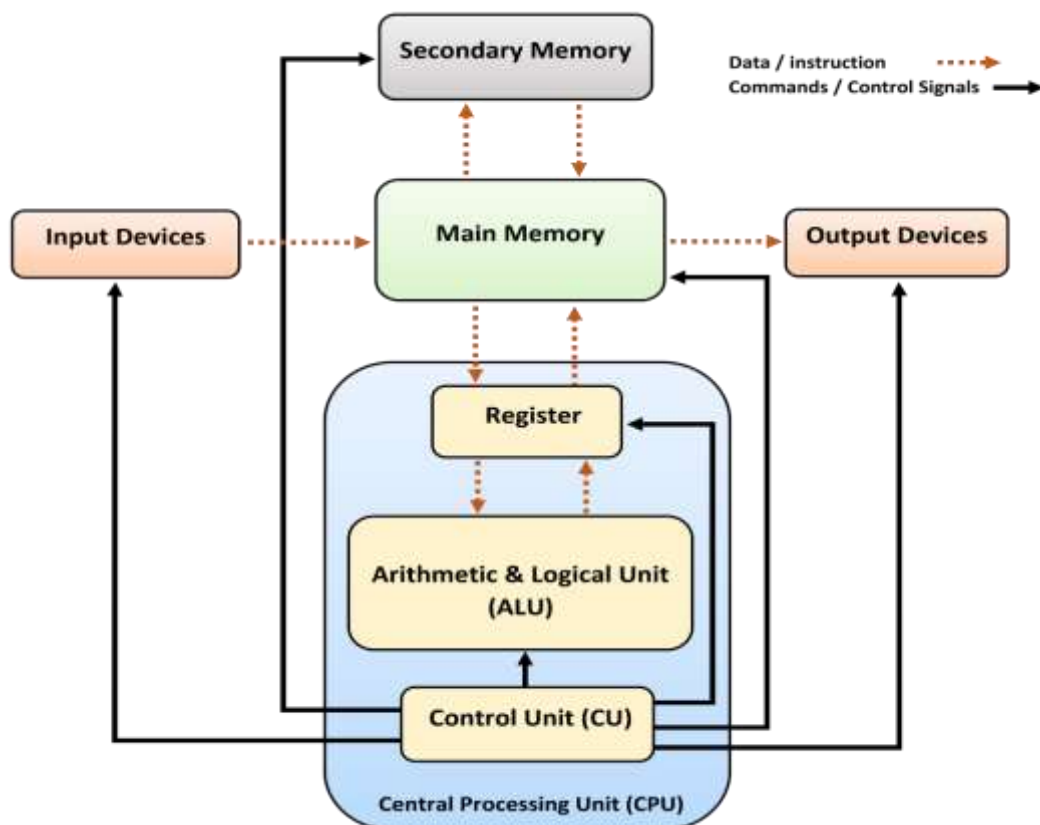

Fig:- Block Diagram of computer System

Input Unit

Input Unit uses for entering data and instructions to the computer system. The raw data given to the computer is called input and the devices used to give the input are known as input unit.

They convert data into electronic form for direct entry or through a telecommunications network into a computer system.

Some common input devices are keyboard, mouse, touch sensitive pad, trackball, joystick, scanner, light pen, voice input device, digital camera and webcam.

Functions:

> » It accepts the list of data and instructions from the outside world.

> » It converts these instructions and data into computer acceptable format.

> » It supplies the converted data and instruction to computer system for further processing.

Processing Unit (Processor/CPU):

CPU is the portion of a computer system that carries out the instructions of a computer program, and is the primary element carrying out the computer's functions.

Processing Unit is responsible for processing the raw data into meaningful information using Central Processing Unit. The processing on data is done on the basis of instructions given to it. CPU (Central Processing Unit) is the main processing unit of the computer system. It controls all the internal and external devices. The function of CPU are as follow:

- Read instruction from memory
- Communicate with all peripherals using the system bus.
- It controls the sequence of instructions.
- It controls the flow of data from one component to another component.
- Performs the computing task specified in the program.

Some of the primary components of a CPU are:
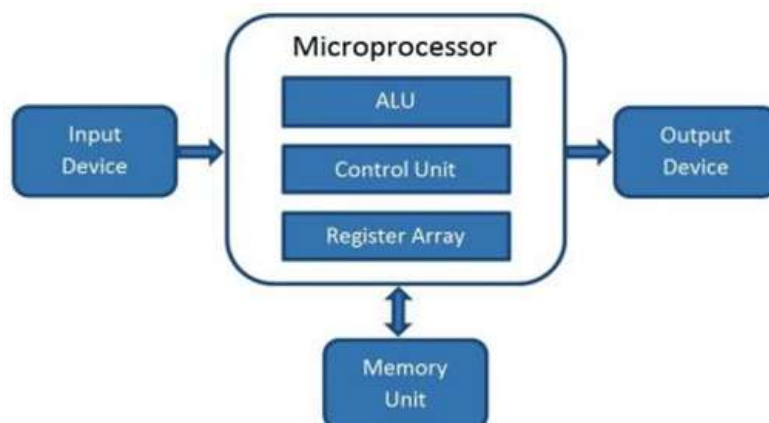
Control Unit

Control Unit is a part of the CPU that controls and coordinates activities of other units of computer system. It acts as a nervous system of computer. It controls the execution of instructions given to system. It coordinates the flow of data in or out of ALU, memory and various input or output devices.

- It performs the data processing operations with the aid of program prepared by the user and send control signals to various parts of the computer system.
- It gives commands to transfer data from the input devices to the memory to an arithmetic logic unit.
- It also transfers the results from ALU to the memory and then to the output devices.
- It stores a program in the memory.
- It fetches the required instruction from the main storage and decode each instruction and hence execute them in sequence.

Arithmetic Logic Unit

Arithmetic logic unit is a part of CPU that can perform arithmetic operation like addition, subtraction, multiplication and division. Logical operation such as comparison AND, OR and Exclusive OR. It also performs logical comparison like equal to, greater than, less than, etc. to compare between two numbers.

- It accepts operands from registers.
- It performs arithmetic and logic operations.
- It returns a result to register or a memory
- The logical operations of ALU give the computer the decision-making ability.

MU (Memory Unit- Register Array)

Memory unit is also a part of CPU but not the part of main memory that store currently executing task. It is located inside the microprocessor and has very limited storage. It is used to store very active data and instructions temporarily during processing. Register are primarily used to store data temporarily during the execution of a program and are accessible to the user through instructions.

Registers are needed during processing, such as
- The address of the next instruction to be executed.
- The current instructions is being decoded.
- The results of calculations of frequently used small amounts of data.

Some of the registers are as follow:
1. **Program Counter (PC)**: Contains the address of the next instruction to be fetched.
2. **Instruction Register (IR)**: Contains the instruction most recently fetched.
3. **Memory Address registers (MAR):** Contain the address of a location in memory for read and write operation.
4. **Memory Buffer Register (MBR):** It contains the value to be stored in memory or the last value read from memory.
5. **Accumulator (ACC):** An accumulator is a general purpose register used for storing temporary result and result produced by the arithmetic logic unit.

Storage Unit:

It provides space for storing data and instructions, space for intermediate results and also space for the final results.

Memory and storage unit is responsible for storing the data and information either temporarily or permanently. The memory devices such as RAM, cache memory stores data temporarily at the time of processing whereas storage units like Hard Disk, Pen Drive etc. stores data and information permanently for future use.

i. **Primary/ Main Memory:**

It is a volatile memory of computer. As soon as a computer starts, primary memory stores all running applications, operating system, user interface and any others. Its storage capacity is smaller but faster.

ii. **Secondary/ Auxiliary storage**:

It is the secondary memory of computer. They have slower access rates but greater storage capacity and data stability. Auxiliary memory holds programs and data for future use because it is non-volatile.

Output Unit:

When the computer its processing task, the results must be conveyed back to the user. Information from the CPU is converted into an understandable form through output devices.

- It provides information and results of computation to the outside world.
- Output Unit is responsible for producing meaningful result in human understandable form to the user because computer works in binary code.
- The processed data are converted into meaningful information and that information is delivered through output unit using output devices like monitor, speaker, and printer.

Common terms used in Microprocessor:

Clock Speed:

The clock speed determines how many instructions per second the processor can execute. The microprocessor has its internal clock that regulates the speed at which it executes instructions and synchronizes it with other components. Clock speed are measured in MHz or GHz where 1 MHz means 1 millions of cycles per second and 1GHz means 1 billions of instructions per cycle.

Word Length:

Word length is the number of bits in the processor can process at a time in single instruction. 8 bits microprocessor can process 8 bits data at a time. The range of word length is from 4 bits to 64 bits. The first commercial microprocessor was Intel 4004 was of 4 bit. It had 4 input and 4 output pins.

Interconnecting the units of a computer

Computer is a set of parallel distinct wires, serving different purposes. It allows devices attached to and communicate with the CPU.

The functions of bus are:

- It carries information from one component to another.
- It carries data, address, or control signal.
- One component of the component can interact with others through bus.

BUS System

The bus provides a communication path for the data and control signals moving between the major components of the computer system.

➢ Bus refers to the path between the components of a computer. Actually bus is set of hardware line(conductor) which lies inside the computer through which data is transmitted from one part of computer to the another part.

➢ The bus is a medium used to transfer data, memory address and control signal from one part to other part of computers.
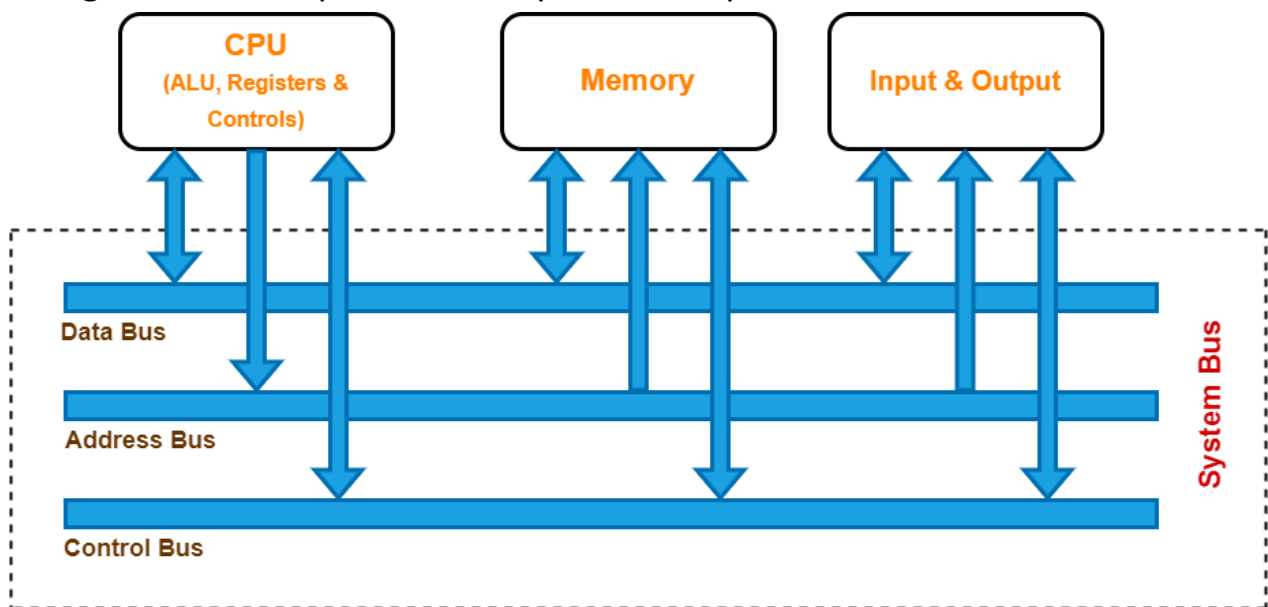
There are three types of bus which are described below:

a. **Address Bus:**

Address bus is the group of wires which carries memory address. A memory address is a numerical value used to identify memory location. Computer performs all its task through memory address. CPU sends memory address to all components. So, address bus is also unidirectional form CPU to other components. The length of address bus of 8085 microprocessor is 16 bit.

Address bus is a group of wires or lines that are used to transfer the addresses of memory or I/O devices. It is unidirectional.

Data Bus:

Data bus is the group of wires that allow to travel data to and forth between memory and CPU. They are used to carry data from one component to another. Data bus is bidirectional. Data can be sent and read form memory. The length of data Bus of 8085 microprocessor is of 8 bit.

Data bus is used to transfer data within microprocessor and memory/input or output devices. It is bidirectional as microprocessor requires sending or receiving data.

Control Bus:

Control bus is the group of wires that caries control signals generated form control unit of CPU. It is unidirectional from CPU to all other components

A control bus is a computer bus used by the CPU to communicate with devices that are contained within the computer. This occurs through physical connections such as cables or printed circuits.

Inside a Computer Cabinet

The computer cabinet contains the components that are required to operate a computer. The computer cabinet consists of the components that are required for running the computer system effectively with fewer errors. There are various elements in the cabinet to which some of them are Motherboard, memory chips, cables, processors, ports, etc.
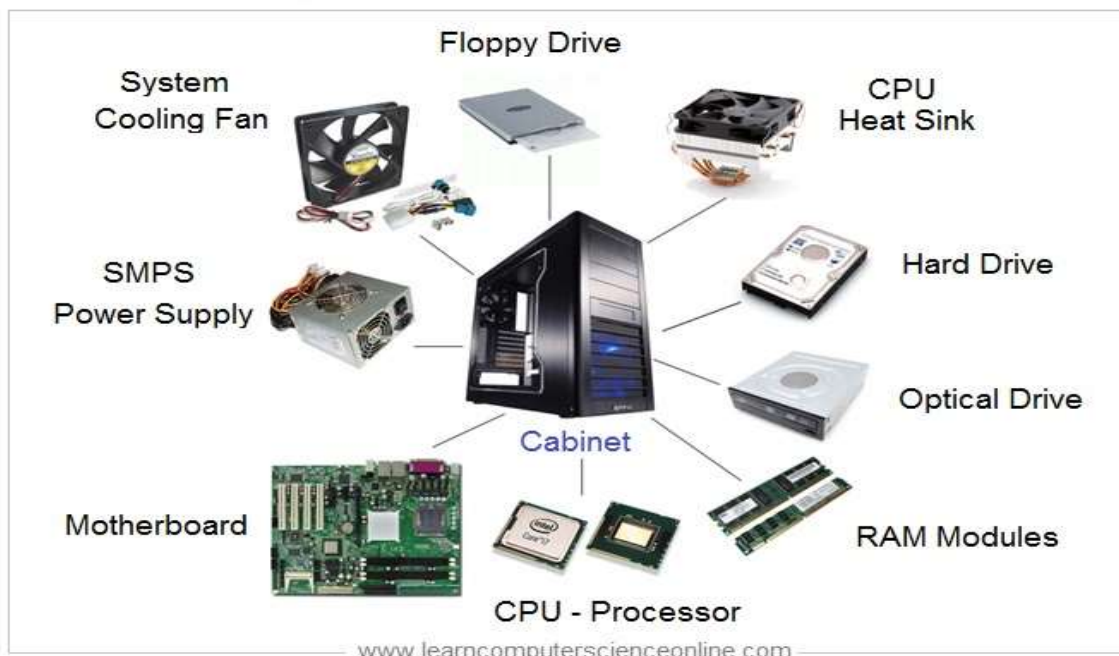
Motherboard

Motherboard is called PCB (Printed Circuit Board) or system board or main circuit board. All parts of computer system like microprocessor, slots, ports etc. are mounted on motherboard. So, it is also called backbone of computer system. The motherboard connects directly or indirectly to every part of the computer. It also connects important chips like ROM chip, Network chip, sound card, etc.

Motherboard

Function of motherboard

a. There are different slot which joins modem, TV card, etc. in motherboard.
b. Motherboard helps in data communication among different hardware.
c. BIOS (Basic Input Output System) programs are stored in ROM and ROM is attached to motherboard to boot the system.

Microprocessor

Microprocessor is an important part of computer hardware. Computer cannot perform the task without a microprocessor. So, it is also called the brain of a computer.

Microprocessor gets data and instructions from various hardware and processes it with the help of software to produce information as an output to the user. It can do arithmetic calculation and logical comparison between two numbers. Nowadays, a trillion of instructions can be processed within a second.

Ports and interfaces

Motherboard has a certain number of I/O sockets that are connected to the ports and interfaces found on the rear side of a computer. We can connect external devices to the ports and interfaces, which get connected to the computer's motherboard.

- Serial Port— to connect old peripherals.
- Parallel Port— to connect old printers.
- USB Ports—to connect newer peripherals like cameras, scanners and printers to the computer. It uses a thin wire to connect to the devices, and many devices can share that wire simultaneously.
- Fire wire is another bus, used today mostly for video cameras and external hard drives.
- J45 connector (called LAN or Ethernet port) is used to connect the computer to a network. It corresponds to a network card integrated into the motherboard.
- VGA connector for connecting a monitor. This connector interfaces with the built-in graphics card.
- Audio plugs (line-in, line-out and microphone), for connecting sound speakers and the microphone. This connector interfaces with the built-in sound card.
- PS/2 port to connect mouse and keyboard into PC.
- SCSI port for connecting the hard disk drives and network connectors.

Expansion Slots

The expansion slots are located on the motherboard. The expansion cards are inserted in the expansion slots. These cards give the computer new features or increased performance. There are several types of slots:

- ISA (Industry Standard Architecture) slot—to connect modem and input devices.
- PCI (Peripheral Component Interconnect) slot—to connect audio, video and graphics. They are much faster than ISA cards.
- AGP (Accelerated Graphic Port) slot—a fast port for a graphics card.
- (Peripheral Component Interconnect) Express slot—faster bus architecture than AGP and PCI buses.
- PC Card—It is used in laptop computers. It includes Wi-Fi card, network card and external modem.

Memory Chips

The RAM consists of chips on a small circuit board. Two types of memory chips— Single In-line Memory Module (SIMM) and Dual In-line Memory Module (DIMM) are used in desktop computers. The CPU can retrieve information from DIMM chip at 64 bits compared to 32 bits or 16 bits transfer with SIMM chips. DIMM chips are used in Pentium 4 onwards to increase the access speed.

Storage Devices

The disk drives are present inside the machine. The common disk drives in a machine are hard disk drive, floppy drive and CD drive or DVD drive. High-storage devices like hard disk, floppy disk and CDs are inserted into the hard disk drive, floppy drive and CD drive, respectively. These storage devices can store large amounts of data, permanently.

Hard disk

Hard Disk is most popular non-volatile secondary storage device used in personal computer. The storage capacity and speed of hard disk is higher than other secondary storage devices. It stores all data of the computer system in the magnetic form. It is usually installed internally in a computer, attached directly to the disk controller of the motherboard. It contains one or more platters coated with the magnetic materials. Data is written on both sides of platters with the magnetic head, which moves rapidly over them as they spins. Hard Disk is important to store the operating system and installation of other programs and files necessary for the user.

It consists of one or more circular disks called platters which are mounted on a common spindle. The surface of each plater is coated with a magnetic material. Both surface of disk are capable of storing data except the top and bottom disk. The only one surface of top and bottom disk is coated with magnetic material. The information is stored and retrieved from the surface of rotating disk by the help of magnetic read/write heads of each surface. These heads are joined to a common arm known as access arm.

SSD

SSD can be defined as the device that contains all the properties of hard disk drives to store the data and use solid-state memory, which has no moving parts. These devices do not use magnetic and optical medium to store data. Rather, these devices use the semiconductor devices. The main objective of these devices is to process the instructions electronically. SSDs have no mechanical parts due to which access time in case of SSDs is less. This provides the facility of faster accessing of data as compared to any other storage devices. The storage capacity of SSD is lower than that of the hard disk. The examples of SSD are flash memory cards and Universal Serial Bus (USB) devices. These devices are widely used in laptops to store data. They also prove to be of great use in the critical applications used in defense industry.

Random Access Memory

RAM is a high speed memory that holds a copy of the operating system, currently executing programs, and other information being processed. It can be written to and read from at any time.

SRAM is a fast memory technology that requires power to hold its content. It is used for high-speed registers, caches and relatively small memory banks such as a frame buffer on a display adapter. Static RAM has a low bit density, high power consumption and is more expensive.

DRAM is a read-write random-access memory whose storage cells are based on transistor-capacitor combinations, in which the digital information is represented by charges that are stored on the capacitors and must be repeatedly refreshed in order to retain the information. The DRAM is cheaper but its access time is slower than that of RAM.

Cooling the System

A computer fan is **any fan inside, or attached to, a computer case used for active cooling**. Fans are used to draw cooler air into the case from the outside, expel warm air from inside and move air across a heat sink to cool a particular component.

The computer generates a lot of heat when it is in use, and if this heat is not properly managed, it can cause permanent damage to the system. The fan works by blowing air over the hot components of the computer, such as the central processing unit (CPU), graphics processing unit (GPU), and other internal components, to dissipate the heat. The fan helps to keep the temperature of the components within a safe range, ensuring the

SMPS

The full form of SMPS is **Switched Mode Power Supply** also known as Switching Mode Power Supply. SMPS is an electronic power supply system that makes use of a switching regulator to transfer electrical power effectively.
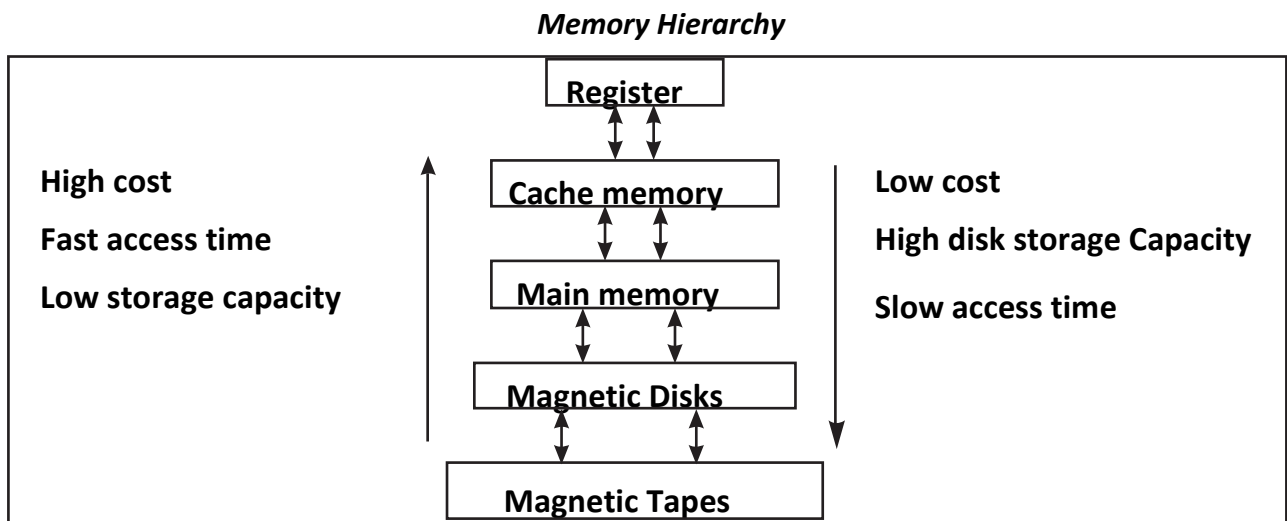
Memory Unit

A computer memory is a computer hardware that stores data, instructions, or programs either temporarily or permanently. It is required by the computer system to store instructions and data for immediate processing and long-term storage.

This unit is also called storage unit. The data and instructions, which are entered through an input unit must be stored on the computer before the actual processing starts. The result produces by the computer after processing is also kept somewhere before passed to the output units. If intermediate results are produced during processing, it should be stored in somewhere in memory.

The storage unit of a computer performs all these needs. In brief, the specific functions performed by the storage unit are as follow:

- It stored data and instructions, which are entered through input devices.
- It stores an intermediate result of processing.
- It stores the final result of processing before these results are passed to an output device.

Memory Hierarchy

Register	
High cost	**Cache memory**	Low cost
Fast access time	**Main memory**	High disk storage Capacity
Low storage capacity	**Magnetic Disks**	Slow access time
	Magnetic Tapes	

On the basis of technological point of view, memory can be classified as below:

1. **Semiconductor memory:** It is the memory that is built by using transistor and IC. It is faster, lighter, has smaller storage capacity and consumes less power. It is used as the main memory of the computer. It has an access time of about 50ns. Examples: ROM, RAM, Cache memory, etc.

2. **Magnetic memory:** It is the memory that consists of magnetic property for storing data. It stores data in the form of magnetized dots. It is slower for read / write and cheaper than semiconductor. It is used as the secondary or backup memory of the computer. Examples: Hard disk, Floppy disk, Tape drive, etc.

3. **Optical memory:** It is the memory that uses optical property (light) to the read-write operation of the data. It is slower and cheaper than semiconductor memory and used for mass storage and backup. Example: CD, DVD, BD, etc.

Access Types of Storage Devices

Access type defines the way or order in which the storage devices are accessed for reading and writing data. The access types of storage devices can be categorized as:

1. **Sequential access:** In this access type, data are accessed serially from the first memory location. It is appropriate for sequential data like audio and video. The average access speed is slower. Magnetic tape is a sequential access device.
2. **Direct access:** In this access type, data are accessed directly from any location in the memory randomly. It can be used to store any types of data. The average access speed is faster than in sequential access. Memory devices like hard disk, CD, DVD, Pen drive are direct access.

S.N.	Direct Access	S.N.	Sequential Access
1	In direct access, data can be accessed directly from any memory location	1	In sequential access, data can be accessed serially from the first memory location.
2	It is appropriate for accessing any type of data.	2	It is appropriate for accessing sequential data like audio and video.
3	The average access time is faster.	3	The average access time is slower.
4	It is not reliable as sequential access.	4	It is more reliable than random access.
5	It is not efficient as sequential access.	5	It is more efficient than random access.
6	It uses disk block to store data.	6	It uses volumes to store data.
7	Memory device like CD, DVD, HDD, Pen drive use direct access.	7	Memory device like magnetic drum, magnetic tape use sequential.

The storage unit of computers consists of two types of memory or storage: primary and secondary storage:
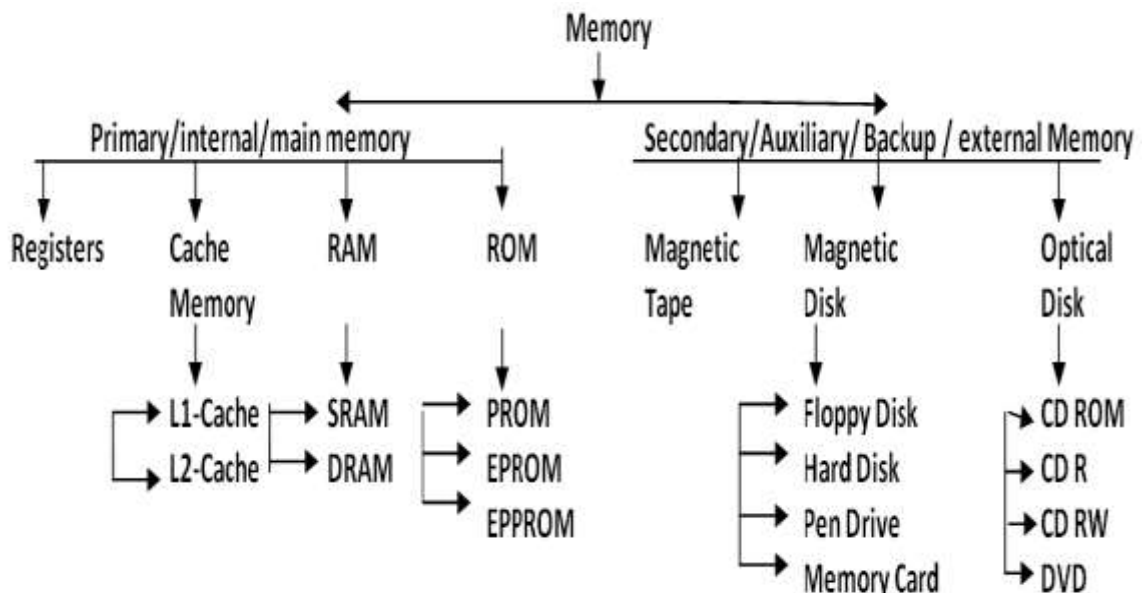
Primary / Main / Internal Storage

Memory storage that communicates directly with CPU is called main memory. It enables the computer to store, at least temporarily data and instruction. It is mainly used to hold data and instructions and as well as the intermediate result of processing which the computer system is currently working on. Primary memory is volatile, that is, it lose its content when power supply is off. The Random access memory (RAM) is an example of a primary to main memory.

Here are some of them that comes under the primary memory

- **RAM (Random Access Memory)**

Fig: Random Access Memory

RAM is the read/write memory of the computer. It is used for both purpose read and write. It possesses random access property that means CPU can access any memory location in a random sequence form.

It is a volatile memory. It stores data or information as long as power supply is on. But, after power supply is off, data will be gone. There are two types of RAM.

Types of RAM

- **Static RAM (SRAM)**

SRAM stores data and programs as long as the computer is in ON state. It is expensive but faster for read/write than DRAM.it is typically used for CPU cache while DRAM is used for a computer's main memory.

IMS 32K Static RAM

Fig: Static RAM

- **Dynamic RAM (DRAM)**

The data stored in DRAM will be lost after a few milliseconds even if the computer is on. It is cheap but slow for read/write than SRAM.

Fig: Dynamic RAM

- **Read Only Memory (ROM)**

ROM stands for Read only memory. It can be used only to perform the read operations. It does not have write access. It is non-volatile memory i.e, the information stored in it is permanent and is not lost even if the power supply is cut down.

Fig: **Read Only** *Memory*

It is used for permanent storage of programs. It is cheaper than RAM on per unit basis but while compared to storage ROM is expensive than RAM.

Types of ROM

- **PROM (Programmable Read Only Memory)**

It is a programmable memory that users can write data at once only. The user can store permanent programs, data or any kind of information in PROM.

Fig: Programmable Read only Memory

- **EEPROM (Electrical erasable programmable read only memory)**

It is a memory that can also be erasable via electric. It can be erased and reprogrammed on the byte by byte basis single data or the entire chip can be erased.

Fig: Electrical erasable programmable read only memory

- **EPROM (Erasable Programmable Read Only Memory)**

It is an erasable memory. Data stored on it can be erasable via passing the Ultra-Violet light so that entire data will be erased.

EPROM
CHIP

Fig: Erasable *Programmable Read Only Memory*

S.N.	RAM	S.N.	ROM
1	RAM is a volatile memory.	1	ROM is a non-volatile memory.
2	RAM is a read and write memory.	2	ROM is a read only memory.
3	RAM holds the program and data the CPU is Presently processing.	3	ROM contains special instructions for detailed computer operations.
4	It is used for buffering purpose.	4	It is not used for buffering purpose.
5	It is higher memory space.	5	It is less memory space.
6	Data are lost when the power supply is switched off.	6	Data are store permanently.
7	Types are SRAM and DRAM	7	Types are PROM, EPROM and EPROM

S.N.	SRAM	S.N.	DRAM
1	It is made up of transistors.	1	It is made up of capacitors
2	It is more expensive.	2	It is less expensive
3	SRAM doesn't need periodic refreshment.	3	DRAM needs periodic refreshment
4	Charges doesn't get leaked from SRAM	4	Data charges gets leaked from DRAM
5	SRAM are less density.	5	DRAM are more density.
6	It is faster than DRAM.	6	It is slower than SRAM.
7	Data is stored in the form of voltage.	7	Data is stored in the form of charge.

S.N.	PROM	S.N.	EPROM
1	It is a Programmable read only memory.	1	It is Erasable Programmable Read only memory.
2	The user can write instructions on PROM only once.	2	The user can write instructions on EPROM many times.
3	The instructions written by the user cannot be erased from PROM.	3	The instruction written by the user Can be erased from EPROM using ultraviolet rays.

4	If there is an error while writing on PROM, it becomes unusable.	4	If there is an error while writing on EPROM, it can still be used again.
5	It provides less usability as instructions are written only once.	5	It provides more usability as instructions are written many times.

S.N.	EPROM	S.N.	EEPROM
1	It is erasable programmable read only memory.	1	It is electrically erasable programmable read only memory.
2	The instruction written in EPROM can be erased using UV rays technology.	2	The instruction written in EEPROM can be erased and reprogrammed using electrical charge.
3	The content is erased bit by bit.	3	The content is erased byte by byte.
4	Selective programming cannot be done.	4	Selective programming can be done.
5	EPROM chip need to be taken out the computer or device to erase the content.	5	EEPROM chip need not to be taken out the computer or device to erase the content.

Cache Memory

Cache memory pronounced as cash, is a special high speed and expensive memory used in CPU, so that CPU doesn`t have to wait for data to be delivered. The most frequently used instructions are kept in the cache memory.

Cache memory computer runs fast and smoothly. It doesn`t have to swap instruction in and out of RAM. Hence, the cache memory is placed in between CPU and RAM so that the speed of operation of main memory and cache memory together can meet speed requirements.

L1 and L2 are levels of cache memory in a computer. If the computer processor can find the data it needs for its next operation in cache memory, it will save time compared to having to get it from random access memory.

Virtual Memory

This is the hypothetical memory into the computer system. Exactly this is logical memory or not real memory exist into the computer system likewise physical memory (RAM).
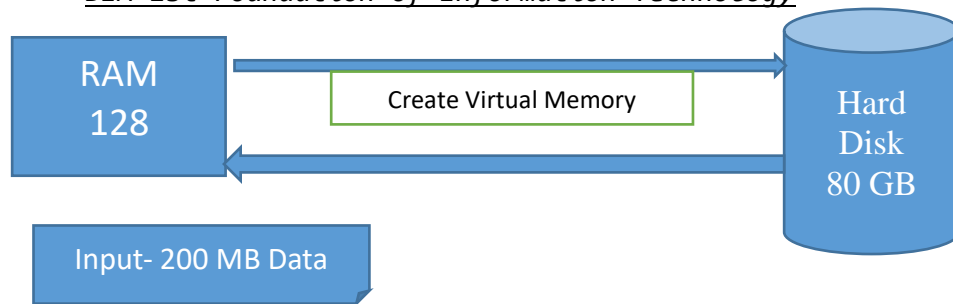
Fig.:- Mechanism of Create virtual Memory

Memory that no longer physically exists within computer system is called virtual memory. Virtual memory is a technique that allows the execution of process that may not be completely in memory. Virtual memory automatically managers two levels of the memory hierarchy representing the main memory (RAM & ROM) and secondary storage (Hard disk). The operating system automatically manages the required space from secondary storage in the case of main memory is not sufficient to run particular program.

Buffer

Buffer is the temporary memory which stores the data from disk to RAM. The behavior of buffer is same as RAM but defined in disk.

It is a temporary holding area for data; unlike register it stores more than one piece of data. It is normally used between the CPU and the input/output devices. The purpose of a buffer is to hold data prior being used by CPU.
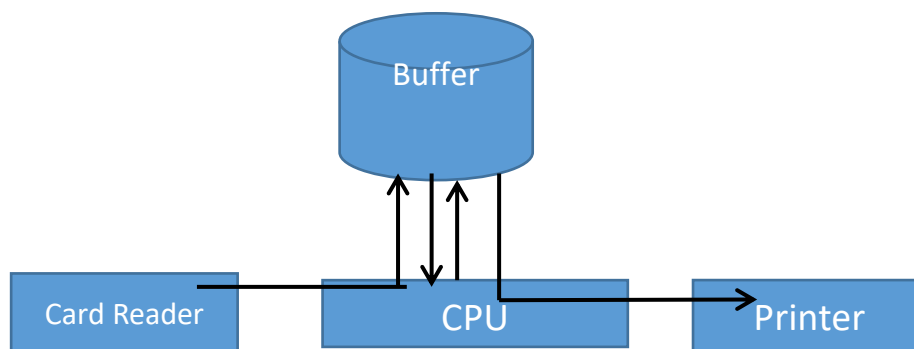
System Buffer

Buffering is a process of utilizing temporary storage such as memory one a file for temporary purpose whereas fastest acting devices. Such as CPU can store data that can by slowly operating devices.

  ➢ Buffer is a small, high speed memory
  ➢ It can be a reserved section of RAM or can be located in the input/ output devices.

➢ The technique which is used to keep both the CPU and input/output device busy all the time is called buffering.

Secondary / Auxiliary / External Storage

Secondary memory is non-volatile and has a lower cost per bit. It generally has an operating speed far slower than that of primary memory. Secondary memory is also called as "Auxiliary Memory". It is primarily used to store a large volume of data on the permanent basis that can be partially transferred to primary storage.

Secondary storage is the storage device that is designed to store data and instructions (programs) in a computer relatively in permanent form. It is non-volatile storage.ie. Stored data and instructions can be retained even if the power supply is cut off. It is also known as backup memory. It is mainly used to transfer data to program from one computer to another computer. There is high capacity storage devices used to store data and program permanently. These are also used as backup devices which allows to store the valuable information as backup on which you are working on. The examples of secondary memory are Magnetic Disk, Optical disk, etc.

Features of secondary memory

1. It is not directly accessible to CPU;
2. It requires primary memory for its operation.
3. It is usually non-volatile memory.
4. It is usually cheaper and slower for read /write operation than primary memory.
5. Data is permanently stored even if power is switched off.

Secondary memory is also called auxiliary memory or backup memory. These memories are used to store data and instructions permanently for future use. CD/DVD, pen drive, hard disk, etc. store data and instruction for future. The various types of secondary memory are Magnetic Tape, Hard disk, SSD (Solid State Drive), Optical Storage Disc, Pen drive, etc.

S.N.	Primary memory	Secondary memory
1	It is also called main memory or internal memory.	It is also called auxiliary memory or backup memory.
2	It is volatile and non-volatile memory.	It is non-volatile memory.
3	The storage capacity is less.	The storage capacity is more.

4	Its types are RAM, ROM, etc.	Its types are: Hard disk, CD/DVD, etc.
5	It is made up of semiconductor.	It is made up of magnetic materials, poly carbon, etc.
6	The data is directly accessed by the processing unit.	The data cannot be directly accessed by the processing unit.

Magnetic Storage

Computer systems need to store data in digital format. One of the most widely used types of digital data storage is magnetic storage. This refers to any type of data storage using a magnetized medium. Several types of magnetized media are used in computer systems, including magnetic tape, floppy disks, Super disks, hard disks, etc.

Magnetic Tape

Magnetic Tape is a usable secondary storage device to store and retain a large volume of data. It is made up of a plastic strip of which one surface is coated with magnetic ink. Analog and digital data are stored in magnetic tape. Normally, minicomputer, mainframe computer, large scale business organization server, etc. uses magnetic tape for backup data and information. Magnetic tape driver are used to store and retrieve the data and information from magnetic tape. The main important function of magnetic tape is to store data safely for a long period of time.

Advantages:
   a. Magnetic tapes can be erased and reused many times.
   b. Large volumes of data can be stored for longer period of time.
   c. Magnetic tape cost much less than other data storage devices.

Disadvantages:
   a. Lack of direct access to records.
   b. Environmental problems-sensitive to dust, humidity and temperature levels.

Magnetic Tape and Tape Drive

Hard Disk

Hard disk is commonly used storage device. It stores large amount of data and information permanently. It is also called fixed disk. It is made of aluminum materials and the surface is coated with the ferromagnetic element. Circular metal discs also called platters to rotate while writing or reading the data and information into them. It stores a large amount of data on hard disk. The speed of the hard disk is measured in rpm (revolutions per minute). The hard disks with 5400 rpm or 7200 rpm are generally used in present-day computer system.

Advantages:

　　a. Large storage capacity

　　b. Stores and retrieves data much faster than a floppy disk or CD-ROM.

　　c. Permanent storage

Disadvantages:

　　a. Slower than RAM and ROM

　　b. The disk is fixed inside the computer and cannot be easily transferred to another computer.

Hard disk capacity

Hard disk must be formatted before use. There are thousands of track on the surface of hard disk. So, each track is divided into various sectors. Each sector stores 512 bytes. Header is used to read and write on hard disk. The storage capacity of hard disk is determined from number of disk or platter it contains and their density.
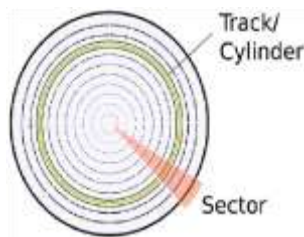

Hard Disk　　　　*Track and Sector*

SSD (Solid State Drive)

Hard disk can be replaced and upgraded by SSD (Solid State Drive) as new technology. Semiconductor chips are used to store data in SSD. The speed to read and write data is greater than hard disk. So its price is more expensive than hard disk. Laptop, notebook, ultra-book, etc. uses SSD as storage device. Its storage capacity is about 4 TB but various companies are trying to develop SSD with high storage capacity. It is more costly than HDD (Hard Disk Drive).
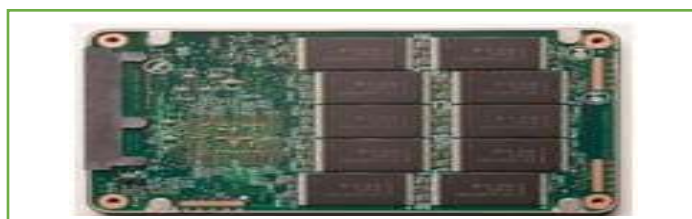
Differences between SSD and Hard disk

S.N.	Hard disk	SSD
1	It is heavier than SSD.	It is lighter than hard disk.
2	Its storage capacity is 500 GB to 100 TB.	Its storage capacity is 1 TB to 4 TB.
3	It is cheaper than SSD.	It is more expensive than hard disk.
4	It takes 6-7 watt electricity.	It takes 2-3 watt electricity.
5	The file writing speed is 50-120 MB/S (megabyte per second)	The file writing speed is 200-550 MB/S (megabyte per second)
6	It is made up of aluminum material.	It is made up of semiconductor microchip.

External Hard Drive

The working principle of hard disk is similar to that of internal hard drive but it is not placed inside CPU casing. It can be externally connected with a USB (Universal Serial Bus) port. It is portable and easy to carry. It is used to transfer data, information and software from one computer to another.

Fig: External Hard Drive

Floppy Disk:

A floppy disk is a flexible disk with a magnetic coating on it. It is packaged inside a protective plastic envelop. These are one of the oldest type of portable storage devices that could store up to 1.44 MB of data but now they are not used due to very less memory storage and less portability. Floppy disk needs FDD (Floppy Disk Drive) to read and write the data on floppy disk. IBM was the first company to create first floppy disk. Floppy disks are of different sizes. The size of floppy disk depends upon its inch size.

Advantages:

    a. It can be used to move files between computers that are not connected through network.

    b. It is used to back up small groups of data files.

    c. Error correction is easier and relatively cheaper.

Disadvantages:

    a. It can be damaged easily by adverse environmental conditions like heat and humidity.

    b. It has less storage capacity and is slower to access than hard disk.

    c. It has to be handled very carefully.

Zip Disk

Zip disk is a medium capacity removable disk storage system, introduced by Iomega in late 1994. Zip disks are thicker and slightly wider than floppy disks. It is capable of storing 100 MB or 250 MB of data.

Flash Memory

Flash memory is a non-volatile memory chip used for storage and for transferring data between a personal computer (PC) and digital devices. It has the ability to be electronically reprogrammed and erased. It is often found in USB flash drives, MP3 players, digital cameras and solid-state drives.

Pen drive

Pen drive is a popular flash storage device. It is also called flash memory. It is connected through the USB ports. It is a small size and portable device. It can be carried in a pocket like pen. So it got its name as a pen drive. It is used to transfer data, information and software from one computer to another. It is made up of semiconductor chip which is EEPROM technology. The writing speed of pen drive of USB 3.0 is up to 60 MB/S and data reading speed up to 120 MB/S.

Fig: Pen drive

Memo Stick

Memory stick is an electronic flash memory data storage device used for storing digital information. It is 50 mm long, 21.5 mm wide and 2.8 mm thick. It is designed to store data and to enable the transfer of data between devices equipped with memory stick slots. It is commonly used in many electronic devices, including digital cameras, mobile phones, laptop computers, MP3 players, and video game consoles.

Advantages:

a. They are very compact and portable media.

b. They are very robust.

Disadvantages:

a. It is not possible to write protect the data and files.

b. Their small physical size means that they are easy to lose.

Optical Storage Disc

The disc that uses laser light technology to store and retrieve data is called optical storage disc. The most commonly used optical storage discs are CD, DVD, Blu-ray disk, etc.

CD (Compact Disc)

In 1980, Philips Company of Netherland developed first CD or optical disk which was 12cm in diameter and had 72 minutes audio/video storage capacity. The laser ray technology is used to retrieve and store the data. The information on the optical disk is stored in the form of pits. The pits are tiny reflective bump.

CD has the diameter of 12 cm. Its weight is 18gm and width 1mm (millimeter). The data can be written on a CD only once. CD is made up of poly carbon and both surfaces are coated with aluminum. Nowadays, CDs are commonly used in microcomputer. It can be used to transfer data from one computer to another.   a CD is 700MB.

The three types of optical storage devices are:

● CD-ROM → Compact Disc – Read Only Memory

● WORM → Write Once Read Many

● CD-RW → Compact Disc – Rewritable

a. **CD-ROM** stores data or programs like video, music, software, etc. for selling purpose developed by different company. The information stored on it is read-only.

b. **WORM** is an optical storage media which is purchased as blank media and data can be written only once but can be read many times.

c. **CD-RW (Compact Disc - Rewritable)** means read and write in it multiple time. It is similar to pen drive as information can be read from and written to the disk many times.

DVD (Digital Versatile Disc)

DVD stands for Digital Versatile Disc or Digital Video Disc. Its storage capacity is higher than CD. It stores multiple layers of data. The various DVD storage capacities are

● Single Side Layer- 4.7 GB

● Single Side Double Layer-8.5 GB

● Double Layer Single Side- 9.4 GB

● Double Layer Double Side-17.08 GB

Philips, Sony, Toshiba/ Panasonic companies developed first DVD in 1995. DVD Drive is used to read/write the data on DVD.

Differences between CD and DVD

S.N.	CD	DVD
1	Its storage capacity is 700MB.	Its storage capacity is up to 20GB.
2	It is cheaper.	It is more expensive.
3	It is used to store audio and software.	It is used to store video and software.
4	Its types are CD-R, CD-RW, etc.	Its types are: DVD-RW, DVD+RW, etc.
5	It was developed by Philips and Sony.	It was developed by Philips, Sony, Toshiba, Panasonic etc.

Blue-ray Disc

It is an optical data storage device. Its storage capacity is up to 200GB. It is mainly used to store high-quality audio and movie data. It is scratch resistant discs.

Blue-Ray Disk often referred to BD disk are also the optical storage devices. BD disks use blue laser beam to read and write data whereas CD/DVD uses red laser beam. Due to this reason more data are stored in less space in BD
Disks, so the storage capacity of BD disk is higher than that of CDs. It is normally used to store large software packages, recording, rewriting, and playing HD videos. It can hold up to 25 GB of data.

Smart Cards

A smart cards is a small card normally of the size of credit card or ATM card or even smaller than that. We can store data and information in the card and sometimes miner processing of data and info made by its built in microprocessor.

Network Storage

Network storage is a generic term used to describe network based data storage. This kind of storage maintains copies of data across high-speed local area network (LAN) connections and is designed to back up files, databases, and other data to a central location that can be easily accessed via standard network protocols and tools.

Cloud Storage

Cloud storage is a cloud computing model in which data is stored on remote servers accessed from the Internet, or "cloud." It is maintained, operated and managed by

a cloud storage service provider on a storage servers. Google Drive and Microsoft's SkyDrive allows you to store files for free up to a specified capacity limit.

Differences between Primary memory and Secondary memory:

S.N.	Hard disk Drive-HDD	S.N.	Solid State Drive-SSD
1	Its storage ranges 500 GB to 100 TB	1	Its storage ranges from 1 TB to 4 TB.
2	It is cheap.	2	It is expensive
3	It consumes more electricity. (6/7w)	3	It consumes very less electricity. (2/3w).
4	It has rotating disk platters.	4	It does not have rotating disks.
5	Produces sound while move.	5	It does not produce sound while working.
6	R/W speed is 50-120 MB/s.	6	It is made of semiconductor memory chips.
7	Platters are made of aluminum.	7	It is made of semiconductor Memory chips.

How the Computer Uses its Memory

The computer starts using the memory from the moment the computer is switched on, till the time it is switched off. The list of steps that the computer performs from the time it is switched on are:

➢ Turn the computer on.
➢ The computer loads data from ROM. It makes sure that all the major components of the computer are functioning properly.
➢ The computer loads the BIOS from ROM. The BIOS provides the most basic information about storage devices, boot sequence, security, plug and play capability and other items.
➢ The computer loads the OS from the hard drive into the system's RAM. CPU has immediate access to the OS as the critical parts of the OS are maintained in RAM as long as the computer is on. This enhances the performance and functionality of the overall system.
➢ Now the system is ready for use.
➢ When you load or open an application it is loaded in the RAM. Since the CPU looks for information in the RAM, any data and instructions that are required for processing (read, write or update) is brought into RAM. To conserve RAM usage, many applications load only the essential parts of the program initially and then load other pieces as needed. Any files that are opened for use in that application are also loaded into RAM.

➢ The CPU requests the data it needs from RAM, processes it and writes new data back to RAM in a continuous cycle. The shuffling of data between the CPU and RAM happens millions of times every second.

➢ When you save a file and close the application, the file is written to the secondary memory as specified by you. The application and any accompanying files usually get deleted from RAM to make space for new data.

➢ If the files are not saved to a storage device before being closed, they are lost.

➢ Sometimes, when you write a program and the power goes off, your program is lost if you have not saved it. This is because your program was in the RAM and was not saved on the secondary memory; the content of the RAM gets erased when the power is switched off.

I/O (Input/Output) devices

Input Unit

The input unit is formed by the input devices attached to the computer. Input devices are used to interact with a computer system or used enter data and instructions to the computer. These devices convert input data and instructions into a suitable binary form such as ASCII, which can be acceptable by the computer. In brief, an input unit performs the following function:

- It accepts data and instruction from the outside worlds.
- It converts these data and instruction into computer understandable from a binary form.
- It supplied the converted data and instruction to the computer system for further processing.

Example of input devices are keyboard, mouse, scanner etc.

INPUT DEVICES

Keyboard

A keyboard is the primary input device through which instructions and data are entered into the computer. It was first invented, in 1868 A.D, in America by Christopher Latham Sholes. This commonly used input device mostly uses a Qwerty layout. The layout is called "Qwerty layout" because such keyboard has those keys as the first 6 letters on top of an alphabetic line of a keyboard.

 Fig: Keyboard

A keyboard is connected to the CPU with a cable. When a key is pressed, an electronic signal is produced which is then detected by an electronic circuit called keyboard encoder. The main function of an encoder is to detect which key has been pressed and to send a binary code that is correspondent to the pressed key of a computer. This binary code may be ASCII, EBDIC or HEX code.

Earlier, keyboard with serial port containing 9 pins was in use. These days, we have USB (Universal Serial Bus) port keyboard and some even wireless. Keyboard with navigation keys like play, pause, next, previous, etc. with multimedia functions is also available. There are 4 types of keyboards for PCs now available. The first 3 were invented by IBM while, the latter is the result of changes made when Microsoft Windows 95 was released. They are:

1. The 83-key keyboard (PC/XT)
2. The 84-key keyboard (PC/AT)
3. The 102-key keyboard (called the extended keyboard)
4. The 105-key Microsoft Windows 95-compatible keyboard)

Mouse

A mouse is a small input device which is used to point, draw and select items that are displayed on the computer screen. The pointer of the mouse is called a cursor. As we move the mouse across the screen, the cursor moves according to the movement of the mouse. It was invented in 1960 A.D by Douglas Engle Bart.

Fig*: Mouse*

A mouse is one of the most important and popular input devices. Its movement and the direction of movement are detected by 2 rotating wheels on the underside of the mouse. These wheels have their axes at right angles where, in each wheel is connected to a shaft encoder which emits electrical pulses for everyday increment

movement of the wheel. The pulses transmitted by the mouse determine the distance moved.

There are different types of mouse found in a market. They are:

a.) Mechanical mouse

A mechanical mouse has a rotating ball at its base. As the user moves the mouse, the ball typically spins a pair of wheels inside the mouse. Each wheel is connected to a shaft encoder, which limits electrical pulses for every incremental movement of wheel. The pulses transmitted by the mouse determines the distance moved. Microsoft and Logitech manufacture mechanical mouse.

b.) **Scroll mouse**: It is a type of mouse which comes with a scroll wheel perpendicular to its surface. This scroll wheel or a mouse wheel is made up of a rubbery disc or hard plastic on the computer mouse. It is generally located between the right and left mouse buttons.

Fig: Scroll Mouse

c.) Optical mouse: It is a more advanced mouse which uses a light source, typically LED (Light Emitting Diode), a DSP (Digital processing) and an optical sensor instead of the regular mouse ball. It uses a light detector such as an image sensor or an array of photodiodes to detect any relative movement to a surface.

Fig: Optical Mouse

d.) Laser mouse: It is an even more advanced mouse which uses laser to detect movements on a surface. It can track more than 2,000 DPI (Dots Per Inch) whereas, a typical optical mouse can track between 400 and 800 DPI only. This mouse emits light to the surface where it is put on. The emitted light is reflected back which tells

the computer to control the pointer on the screen. Generally, laser mouse available nowadays is connected to the USB (Universal Serial Bus) port.

Laser Mouse

Fig: Laser Mouse

e.) Wireless Mouse: Wireless mouse is also referred as cordless mouse. It describes the technology that transmits information on electricity through the air electro-magnetically without the use of wires. A USB receiver is used to connect the computer with the wireless mouse.

Joystick

The joystick was invented, in 1944 A.D., in Germany but the video game joystick was invented in, 1967 A.D. A joystick is a stick which is mounted on a spherical ball which moves in a socket. It allows the user to navigate easily around the display on the screen. A user may move the stick on the device in different directions. This is particularly useful at homes for playing video games and for indicating positions in graphic systems.

Logitech Freedom 2.4 Joystick

http://www.computerhope.com **Fig: Joystick**

- **Touch Pad**

A touch pad is a small touch-sensitive pad that is used as a pointing device in portable computers. It can be used in place of an external mouse. It uses pressure sensors to track the position of a device on its surface. Each position on the touch pad is translated to the specific location on the screen. A touchpad is operated by using your finger.

Fig: Touch Pad

- **Track Ball**

A track ball is an upside down of a roller mouse. It was used to be a basic input device in laptops earlier. It is similar to the mouse but with a mouse, the ball is rolled by moving the entire unit over the surface whereas, with track ball, the ball itself is rolled with fingers.

Fig: Trackball

- **Scanner**

The scanner is an input device that needs images or text and converts the data into digital signals. The image is scanned and converted into a format that the PC can interpret. It was invented by Rudolph Hell, in 1963 A.D, in Germany.

Fig: Scanner

A scanner works by digitizing an image, dividing it into a grid of small dots called pixel and representing each dot with RGB value for that pixel value by binary bits. The resulting matrix of bits is called a bitmap, which can be stored in a file and can be displayed on a screen.

- **Bar Code Reader**

The Bar Code Reader is a device which is used to read a barcode field. Bar Code is a technology that uses white spaces and black bars to represent encoded information. This encoded information can be read with an optical device that converts the bars and spaces into an electrical signal which is then decoded into the original characters. The bar code was invented by Woodland.

Fig: Barcode reader

The bar code reader is used in labeling consumer products and books. It is detected as ten digits. The first 5 digits identify the supplier or manufacturer of the item whereas, the second 5 digits identify an individual product. The code also contains a check digit to ensure that the information read is correct.

- **Light Pen**

A light pen is a pencil shaped device which is used to select screen positions by detecting the light coming from points on a screen. It was 1stinvented in 1952 A.D, in MIT (Massachusetts Institute of Technology). A light pen is sensitive to the short burst of light emitted from the phosphor coating at the instant the electron beam strikes on a particular point.

Fig: Light pen

Though the light pens are still in use, they are not as popular as they used to be as they have several disadvantages comparing to other input devices.

- **OCR (Optical Character Reader)**

Optical Character Reader (OCR) is the device that helps in the recognition of printed or written text characters by a computer. OCR is used for reading text from paper and translating it into a form that the computer can manipulate. An OCR reader scans the document using the photoelectric device to convert it into electric signals. These patterns are then compared with the stored patterns of the characters which the reader can recognize. If a match is found, the character scanned is identified otherwise, it is rejected by the reader. This device is widely used in airlines, banks, postal offices (for reading postal code), etc.

Fig: Optical Character Reader

- **OMR (Optical Mark Reader)**

Optical Mark Reader is widely used device for scoring answers for multiple choice questions. It can sense the presence of a pen or pencil mark. Special marks such as squares or bubbles are prepared on examination answer sheets or questionnaires .The user fills in these squares or bubbles with soft pencil or ink to indicate their choice. These marks are detected by the Optical Mark Reader and the corresponding signals are sent to the processor.

Fig: Optical Mark Reader

- **MICR (Magnetic Ink Character Reader)**

Magnetic Ink Character Reader has been used to read documents that are written by a special ink made of a magnetic material called magnetic ink. MICR is capable of reading characters on a paper written with the magnetic ink which is magnetized during the input process. The MICR reads the magnetic pattern of the written

characters. To identify the characters, these patterns are compared with a special pattern stored in the memory. It is mostly used in banks and postal services.

Fig: Magnetic Ink Character Reader

- **Touch Screen**

Touch screen is a kind of screen which is sensitive to user's touch. One can use a finger to point the command or menu displayed on the screen. Touch screen was invented in 2009 A.D, in Apple store. It is widely popular on laptops.

Fig: Touchscreen

- **QR Code Scanner**

It stands for Quick Response Code. The advanced form of Reader is QR Code Scanner. A QR code is a pattern of white squares. The QR code of any product gives about the website address. A QR code can be read and processed by a smartphone *QR Code* or a cell phone with the help of Apps or Applications.

- **Voice Input System**

The input system which is used to give the instruction to the computer invoice, without using the keyboard i.e. without typing is called Voice Input System. In Voice Input System, the speech is converted into electrical signals employing a microphone. The signals are sent to a processor for processing. Then, the signal pattern is compared with the pattern already stored in the memory .A word is recognized only when a choice is found, and then, the computer gives a corresponding output.

Fig: Voice Input System

A voice recognition system can be used in factories at places where both hands of workers are engaged in the job like if he is doing some handful of work and he wants to input some data into the computer. It can also be used to assist handicapped people or for identification purposes in banks, etc.

OUTPUT UNIT

The output unit is formed by the output devices attached to the computer. Output devices are used to present result produced by the computer to the users. The output from the computer is in the form electric signals, which is then converted into human understandable form into human readable form.

The examples of output devices are the monitor, printer and speaker.

The main functions of the output unit are as follow:

- Accepts the result produced by the computer which is in electric binary signals.
- It then converts the result into human readable form.
- Finally, it supplied the converted results to the outside word.

Output devices

A computer peripheral is a device that is connected to a computer but is not part of the core computer architecture.

Hardcopy

These type of output are in print form on the paper or some material that can be touched and carried for being shown to other. It is permanent in nature. So that we can look after these output even there is no computer.

Unlike soft copy output, these type of output does not need continuous supply of power. For example, Output produce in paper or other material by printer or plotter is known as hard copy output and the device is known as hard copy output device. The commonly used hard copy output devices are printer and plotter.

Softcopy

Soft copy output refers to the data shown on display screen or produced by speaker. These type output is untouchable. It is temporary in nature that means, output cannot be carried for being shown to others. These types of output resides only when there is computer or

continuous electric supply. It is non-portable compared to hard copy output. For example, Output produced on display screen or sound produced from speaker are soft copy output and whereas the device is known as soft copy output device. The commonly used soft copy output devices are speaker and monitor.

Output Device

The device which displays meaningful information from the computer is called an output device. So, an output is the result produced by processing unit. The common output devices are monitor and printer. Some other output devices are: plotter, speaker, headphone, etc.

Monitor

Monitor is the most common output device. It is also called VDU (Visual Display Unit) in computer system. The output displayed on monitor's screen in the form of text, videos and graphics is called soft copy output. On the basis of colour the monitors are of two types:

i.   Monochrome monitor and   ii.   Colour Monitor

Monochrome monitor

The monitor which display output in one colour like green, white, black, blue, etc. is called monochrome monitor.

Colour monitor

The monitor which displays output in different colours more than sixteen is called colour monitor.

The information displayed on the screen is made of combination of small tiny dots. The small tiny dots are called pixel.

The clear screen consists of three terms as screen resolution, dot pitch and refreshes rate.

i.   Screen Resolution

It represents the number of horizontal and vertical pixels. The clear screen is due to the high resolution of the monitor. The common resolution ranges are 640x480, 1024x768, 1600x1200 etc.

ii.   Dot Pitch

The dot pitch is a measure of how close the pixels or dots are to create an image on the monitor. So, it is measured in millimeter. The clear screen is due to the low dot pitch of the monitor.

iii. Refresh Rate

The refresh rate is the rate due to each pixel on screen re-drawn. A low refresh rate results in a poor image on the screen. It is measured in hertz. So, the clear image is due to the high refresh rate.

On the basis of technology, monitors are classified into three types as:

i. CRT Monitor

CRT stands for Cathode Ray Tube. It operates in the following ways:

● The electron gun emits a beam of electrons cathode rays.

● The electron beam passes through focusing and deflection systems that direct it towards specified positions on the phosphor-coated screen.

● When the beam hits the screen, the phosphor emits a small spot of light at each position contacted by the electron beam.

● It redraws the picture by directing the electron beam back over the same screen points quickly.
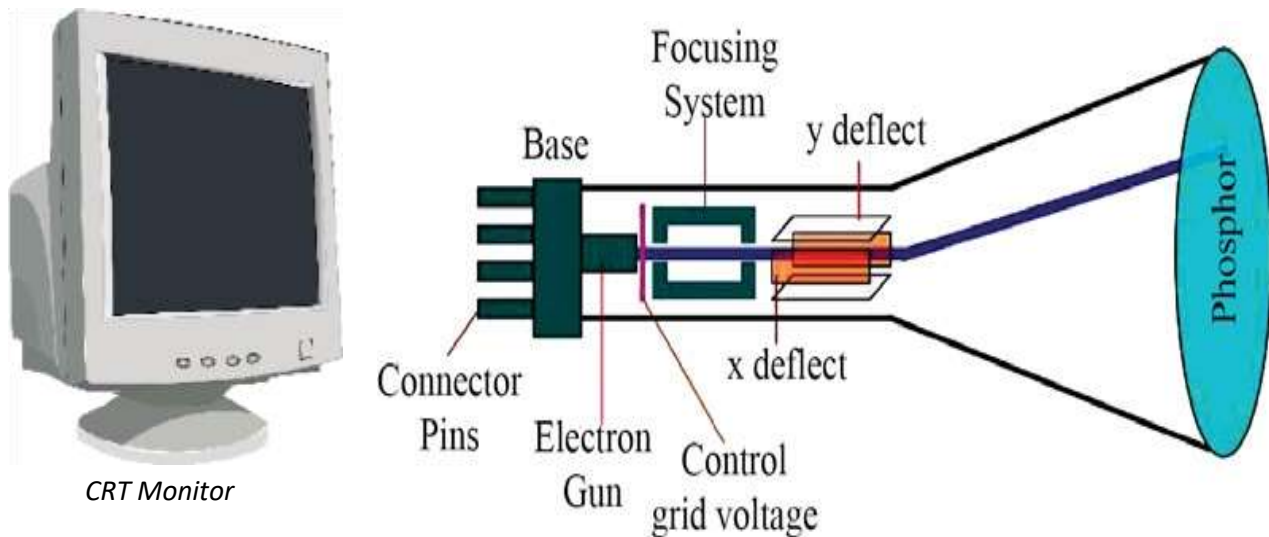
CRT Monitor

There are two ways Random scan and Raster scan by which we can display an object on to the screen.

ii. LCD Monitor

LCD stands for Liquid Crystal Display. It is very light, thin and consumes less power than CRT monitor. The two-layer in this monitor which consists of liquid crystal form an image. It is used in laptop, notebook, digital watch, desktop computer, etc. It is more expensive than CRT monitor and produces a high quality image on the screen. The fluorescent lamps are used for backlighting in LCD monitor for displaying image on the screen.

LCD Monitor

iii. LED Monitor

LED stands for Light Emitting Diode. It is very lighter and thinner than LCD and CRT monitors. It consumes less power than CRT and LCD monitors. Its working power is higher than others. So its lifetime is more and can be used for long-time-work. The quality of image on the screen is higher than that of other monitors. The diodes are used for backlighting in LED monitor for displaying the image on the screen. LCD and LED monitors are called flat panel displays.

LED Monitor

ii. Printer

Printer is a hard copy output device. It prints text & graphics on paper. There are many different types of printers available in market. Its speed is measured by CPS (Character per second), LPM (Line per minute) and PPM (Page per minute). The printers are classified in two types on the basis of printing quality. They are:

- Impact printer
- Non-impact printer

Impact Printer

An impact printer is a type of printer that operates by striking a metal or plastic head against an ink ribbon. Its structure is like a typewriter. It uses small pin-like objects or hammers that strike on the inked ribbon and characters are formed on the paper. These printers are slow and noisy. These printers use black or blue or red colour. The printing quality of impact printer is lower than non-impact printer.

The three main types of impact printer are following:

i.   Dot Matrix Printer

Dot-matrix printer is a type of impact printer. The printer head contains a number of pins. The printer head strikes on the inked ribbon, the striking forms dotted characters on the paper. The speed of Dot-matrix printers ranges from 50 to 400 CPS (Character Per Second).

Dot Matrix Printer

ii.   Daisy Wheel Printer

Daisy wheel printer is a type of impact printer. It uses hammer-like object to hit on the ink ribbon and a character is formed on the paper. The hammer contains letter face and is arranged in wheel like form and motor spins the wheel at a rapid rate. When desired characters spin to the correct position, a printer hammer strikes on the ribbon and output is formed on the paper. The speed of the daisy wheel printer ranges from 25 to 55 CPS (Character Per Second).

Print Head of Daisy Wheel

iii.   Line Printer

Line printer is a type of impact printer. Its printing quality is better than that of Daisy wheel printer and Dot- matrix printer. It prints text line by line. So, it is called a line printer. The three types of line printer are:

Drum printer: In this type, there is a cylindrical drum which continuously rotates over the paper surface and causes characters rise and hits on the ribbon.

Chain Printer: In the chain printer, high-speed print chain is used. This chain contains different types of characters.

Drum Printer

Band Printer: In this line printer, steel print band is used to print one line printout on paper at a time.

Non-Impact Printer

The non-impact printer does not use the printing head to strike against ribbon and paper. Instead, small drops of ink are sprayed onto the paper. So non- impact printers are faster and are of high quality than impact printer. It does not produce sound while printing.

Inkjet printer, laser printer, 3D printer are the popular types of non- impact printer.

i. Ink-jet Printer

Inkjet printer prints text and graphics on paper by spraying small drops of ink into paper. The speed of inkjet printer is generally 1 to 4 pages per minute. It uses an A4 size paper. The liquid colour-filled cartridge is used instead of ink ribbon. Colour inkjet printer uses black colour. Four colour-CMYK (Cyan, Magenta, Yellow, Black) cartridges are used for colour printout.

Inkjet Printer

ii. Laser Printer

A laser printer is a type of printer which makes use of a laser beam to produce an image on the drum or you can say that it is a printer that makes use of a focused beam of light to transfer text and images onto paper. It was first developed by Gary Starkweather at Xerox PARC in 1971. Laser printer makes use of laser technology for the printing of copies onto the paper. Its printout technology is like a photocopy machine. It uses colour powdered toner to print text and graphics on paper. Its printing quality is high.

Laser Printer

iii. 3D – Three Dimensional Printer

Impact printer & non-impact printer prints text on paper but 3D printer prints an object. For example, any playing toys or any machinery parts are printed through the 3D printer. 3D printing builds parts out of plastic, metal and other materials directly from CAD (Computer-Aided Design) drawings that have been cross-sectioned into thousands of layers. This technology helps to build a 3D object by modelling. This technology is called additive manufacturing.

3D Printer

iii. Graphic Plotter

The graphic plotter is a hard copy output device which is used for good quality print or drawing like charts, map, engineering design, etc. Figures or maps are printed on graph paper placed on square board. The graphic plotter is used to print large size figure or map. It gets instruction from computer and draws a clear image by using pen. The different types of plotters are given below.

Pen plotter: Pen plotter contains one or more pen. It prints colour drawing with shade.

Electrostatic plotter: Electrostatic plotter does not contain any type of pen. It prints like laser printer.

Dot-matrix plotter: Dot matrix plotter prints drawing like impact printer. Print head strikes on ink ribbon and prints images on paper.

Speaker

Graphic Plotter

iv. Speaker

Speaker is a common audio output device. It is used to receive sound or music from computer system. It is used to covert digital data into audio analog data which user can understand. The quality of sound output depends on the speaker's quality. For example, loud speakers, sub woofers, in- wall/ceiling speaker, outdoor speaker, etc. are the different types of speakers.

Printer

Different types of printers are described below:

a. **Dot matrix**- printer: Dot matrix printer is an impact printer that produces text and graphics when tiny wire pins on the print head strike the ink ribbon. The print head runs back and forth on the paper like a typewriter. When the ink ribbon presses on the paper, it creates dots that form text and images.

   Advantages :
   i.   Can print on multi-part forms or carbon copies.
   ii.   Low printing cost per page.
   iii. Reliable, durable.

   Disadvantages :
   i.   Noisy.
   ii.   Limited print quality.
   iii. Low printing speed.
   iv.   Limited color printing.

b. **Inkjet printers:** These are non-impact printers which print text and images by spraying tiny droplets of liquid ink onto paper. They are the most popular printers for home use.

   Advantages :
   i.   Low cost.
   ii.   High quality of output, fine and smooth printing.
   iii. Good color printing

iv. Easy to use.

v. Faster in processing

Disadvantages :

i. Print head is less durable.

ii. Expensive replacement ink cartridges.

iii. Not good for high volume printing.

iv. Cannot use highlighter marker on inkjet printouts.

c. **Laser printers:** Laser printers are non-impact printers which can print text and images in high speed and high quality resolution, ranging from 600 to 1200 dpi.

Advantages :

i. High resolution.

ii. High print speed.

iii. No smearing.

iv. Cheap printing

v. Good for high volume printing.

Disadvantages :

i. They are more expensive than inkjet printers.

ii. Except for high end machines, laser printers are less capable of printing vivid colors and high quality images such as photos.

iii. They cost of toner replacement and drum replacement is high.

iv. Warm up time is needed.

Impact printer	Non-Impact Printer
1. It uses electro-mechanical mechanism that causes hammers or pins to strike against a ribbon and paper to print the text	1. It uses thermal, chemical, electrostatic, laser beam or ink jet technology for printing the text and images.
2. It is slow while printing.	2. It is fast while printing.
3. It uses force for printing and produces more sound while printing.	3. Since it doesn't use force for printing it produces less sound while printing.
4. It cannot print graphics perfectly.	4. It can print graphics perfectly.
5. It is usually single colored.	5. It can be single or multi-colored.
6. It is rarely used at present.	6. It is widely used at present.

examples: Dot matrix printer, Typewriter etc.	Examples: Ink jet printer, laser printer etc

Hardware Interface

In computer system several devices plays an essential role in processing data and making the computer work. In the absence of those devices it is impossible to give data and instructions to the computer and receive the output from the computer system. These devices are connected to the motherboard through various links. Hardware interface are the ports which connects various peripheral devices to the computer system. A device is connected to the computer system through the port.

There most common hardware interface are the:

Serial port

Serial port is the connecting interface which can transmit only one bit of data at a time. These ports transmit data sequentially one bit at a time so they need only one wire to transmit 8 bits. Serial ports are slower than parallel port because only one bit can transmit at one time.

Serial ports are usually of 9-pin or 25 pin connectors.

They are also known as communication port or RS323C ports.

They are used for external modems and older computer mouse.

Parallel port

Parallel port is the connecting interface which can transmit more than on bit simultaneously. It facilitates the parallel communication transferring multiple bits of data at one time. They can transmit 1 byte or 8 bits of data at a time. Parallel ports are usually of 25 pin and are used to connect printer, scanner etc.

USB ports:

USB stands for Universal Serial Bus. It is the industry standard for short distance digital data connection.

USB port is a standardized port to connect all kinds of external USB devices such as external hard disk,

Printer, camera, keyboard, speaker, Pen Drive etc.

HDMI

HDMI stands for ***High Definition Multimedia Interface.*** It is the trademark brand name for digital interface used to transmit audio and video in a single cable. It is supported by modern audio/video equipment.

While other types of A/V connections require separate cables for audio and video data, a single HDMI cable carries the audio and video streams together, eliminating cable clutter.

Because HDMI is a digital connection, HDMI cables are less prone to interference and signal noise than analog cables.

Expansion Slot:

Expansion slot are the connection or port on the motherboard. They are the installation point for a hardware expansion card to be connected. For instance, if new video card is to be inserted in computer, it will be installed in the expansion slot. Expansion slots helps to connect new card such as video card, sound card or network card to expand the computer capabilities.

Working of I/O System

I/O refers to input and output. The working of I/O system combines I/O hardware and I/O software.

- ➢ The I/O hardware includes I/O devices, Ports, buses, and devices controllers for different devices.
- ➢ The I/O software is the devices driver software that may be embedded with operating system or comes along with each device.

The working of I/O system is described as follows:

1. **I/O Devices** are attached to computer via the ports of computer. There are many standard ports available on the backside of the computer case like serial port and parallel port. If one or more devices use a common set of wires, it is called a bus. For example, PCI bus, PCI Express bus, etc.

2. **Device Controller** operates on a bus, a port or a device. It controls the signals on the wires of port or bus. The controllers have one or more registers for data and control signals. Controller may be simple like a serial port controller for a serial port, or, complex like a SCSI controller. Some devices have their own built-in controllers.

3. **Device Driver** is software via which the operating system communicates with the device controllers. Each device has its own device driver, and a device controller which is specific to the device. The device drivers hide the differences among the different device controller and present a uniform interface to the operating system.

4. **Application programs** use an I/O device by issuing commands and exchanging data with the device driver. The device driver provides correct commands to the controller, interprets the controller register, and transfers data to and from device controller registers as required for the correct device operation.