



Elementary information about Digital computer

Course Instructor: Dr Anil Kumar Yadav
**Course: Computational methods and
programming**

Note: Content of this documents are to be used only for teaching purpose

Text Reference

- Numerical Methods by E Balagurusamy
- Internet websites

Contents

- Needs of computer
- What is Computer?
- Evolution of computers
- Memory and Storage Systems
- Input Devices
- Output Devices

Need of Computer

- Numerical methods cannot be solved without the help of computers
- Engineers and scientists make use of the high-speed computing capability of computers to solve complex mathematical models and design problems.
- Computers have helped automation of many industrial and business systems.
- Computer aided design (CAD) and computer-aided manufacture (CAM) are among the most popular industrial applications.
- Modeling and simulation are another area where computer are extensively used for research mainly physical and social sciences, medicine, astronomy and meteorology.
- Business and commercial organizations
- To store large amount data in libraries, documentation centers, employment exchange, police department and hospitals etc.
- In games, like Olympics and cricket
- Computer become an integral part of our everyday life.

What's a Computer?

- A **computer** is an *electronic machine* that takes input from the *user*, processes the given input and generates output in the form of useful information.
- Computers are machines created and managed by humans. A computer has no brain of its own. Anything it does is the result of human instructions.
- Computers lack common sense !!

What's a ..

Type of Input: data, programs, user reply

- **Data:** the raw details that need to be processed to generate some useful information.
- **Programs:** the set of instructions that can be executed by the computer in sequential or non-sequential manner.
- **User reply:** the input provided by the user in response to a question asked by the computer.

Characteristics of Computer

Modern computers following characteristics:

- **Perform complex and repetitive calculations rapidly and accurately**
- **Store large amount of data and information**
- **Hold a program or model to explore in many different ways**
- **Make decisions**
- **Automatically correct or modify certain parameters of a system under control**
- **Draw and print graphs**

Characteristics

The unique capabilities and characteristics of a computer:

- **Speed**
- **Storage capacity**
- **Accuracy**
- **Reliability**
- **Versatility**
- **Diligence**

Evolution of Computers

- Manual Computing Devices: Sand table, Abacus, "Pascaline" (numerical wheel calculator) ...
- **Charles Babbage:** Who was working as professor of mathematics at the Cambridge University in 1834 AD, is considered to be the father of modern computer.

Generation of computers

- With the development in technology with time, computer generations also changes.
- The modern age of computer is the fifth generation of computer.

Generations of

First Generation Computers (period 1946-1955)

- Used the vacuum tubes technology for calculation as well as for storage and control purpose.
- Advantages: (1) Fastest computing devices of their time; (2) These computers were able to execute complex mathematical problems in an efficient manner.

Disadvantages:

- (1) The functioning of these computers depended on the machine language.
- (2) They were generally designed as special-purpose computers.
- (3) The use of vacuum tube technology make these computers very large and bulky.
- (4) They were not easily transferable from one place to another due to their huge size and also required to be placed in cool places.
- (5) They were single tasking because they could execute only one program at a time.
- (6) They generated huge amount of heat and hence were prone to hardware faults.

Generations of

Second Generation Computers (period 1956-1965)

Use transistors in place of vacuum tubes in building the basic logic circuits.

Advantages: (1) Fastest computing devices of their time;

(2) Easy to program because of the use assembly language;

(3) Could be transferred from one place to other very easily because they were small and light;

(4) Require very less power in carrying out their operations;

(5) More reliable, did not require maintenance at regular intervals of time.

Disadvantages:

(1) The input and output media were not improved to a considerable extent

(2) Required to be placed in air-conditioned places

(3) The cost of these computers was very high and they were beyond the reach of home users

(4) Special-purpose computers and could execute only specific applications

Generations of

Third Generation Computers (period 1966-1975)

Use of Integrated Circuits

Advantages: (1) Fastest computing devices;

(2) Very productive;

(3) Easily transportable from one place to another because of their small size;

(4) Use high-level languages;

(5) Could be installed very easily and required less space;

(6) Can execute any type of application.

(7) More reliable and require less frequent maintenance schedules.

Disadvantages:

(1) The storage capacity of these computers was still very small;

(2) The performance of these computers degraded while executing large applications, involving complex computations because of the small storage capacity;

(3) The cost of these computers was very high;

(4) They were still required to be placed in air-conditioned places.

Generations of

Fourth Generation Computers (during 1976-1989)

Use of Large Scale Integration technology and Very Large Scale. Integration technology. The term Personal Computer (PC) became known to the people during this era.

Advantages:

- (1) Very powerful in terms of their processing speed and access time;
- (2) Storage capacity was very large and faster;
- (3) Highly reliable and required very less maintenance;
- (4) User-friendly environment;
- (5) Versatile and suitable for every type of applications;
- (6) Require very less power to operate.

Disadvantages:

- (1) The soldering of LSI and VLSI chips on the wiring board was not an easy task and required complicated technologies to bind these chips on the wiring board;
- (2) The working of these computers is still dependent on the instructions given by the programmer.

Generations of

Fifth Generation Computers

- The different types of modern digital computers come under this category.
- Use Ultra Large Scale Integration technology that allows almost ten million electronic components to be fabricated on one small chip.

Advantages:

- (1) Fastest and powerful computers till date;
- (2) Being able to execute a large number of applications at the same time and that too at a very high speed;
- (3) Decreasing the size of these computers to a large extent;
- (4) The users of these computers find it very comfortable to use them because of the several additional multimedia features;
- (5) They are versatile for communications and resource sharing.

Types of Computers

- Computers may be classified based on operating principles, size and capability, and applications.

(I) Based on operating principles:

Analog computers: represent data in the form of continuous electrical signals having a specific magnitude

Digital computers: store and process data in the digital form.

Hybrid computers: a combination of analog computer and digital computer because it encompasses the best features of both.

(2) Based on applications:

General purpose computers: can work in all environments.

Special purpose computers: can perform only a specified task.

(3) Based on size and capability

Microcomputers: A microcomputer is the smallest general-purpose processing system. Designed to be used by one person at a time.

Mini Computers: Can handle more data and more input and output than micro computers and designed to serve multiple users simultaneously.

Mainframe Computers: Computers with large storage capacities and very high speed of processing and used to bulk data processing such as census, industry and consumer statistics etc.

Super Computers: The fastest type of computer that can perform complex operations at a very high speed. Supercomputers play an important role in the field of computational science such as quantum mechanics, weather forecasting, climate research etc.

A computer consists of

various devices:

- Central Processing Unit (CPU)
- Monitor
- Keyboard and Mouse

Computing concepts

- Receives the raw data
- Processing the data
- Storing the data
- Delivering the output

The Computer System

- Hardware
- Software
- Data
- People

Central Processing Unit (CPU)

It is also known as processor, microprocessor or a computer processor

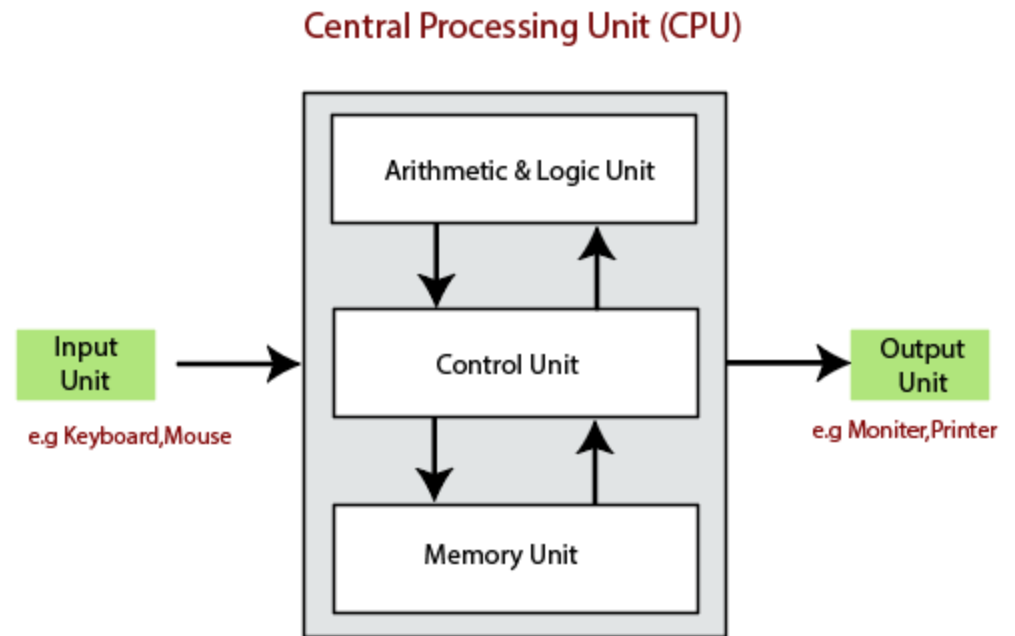
The main operations of the CPU include four phases:

- (1) Fetching instructions from the memory (reads instruction from memory)
- (2) Decoding the instructions to decide what operations to be performed
(A circuitry called instruction decoder decodes all the instructions fetched from the memory)
- (3) Executing the instructions
- (4) Storing the results back in the memory

(The speed of processor is measured by the number of clock cycles a CPU can perform in a second. The CPU speed is measured in Hertz. Modern days CPU has speed in GHz).

Components of CPU

- Registers
- Arithmetic Unit
- Logic Unit
- Control Unit



Arithmetic Unit

- This unit is used to perform all the arithmetic and logic operations such as addition, multiplication, subtraction, division and comparison etc.

Logic Unit

- Logic Unit is a part of the CPU that performs logical operations on the data.

Control Unit

- Control Unit is an important component of CPU that controls the transfer of data and information between various units. It maintains the sequence of operations being performed by the CPU.

Main Memory Unit

- The main memory is referred to as the internal memory or primary memory of the computer. It is also known as Random Access Memory (RAM).

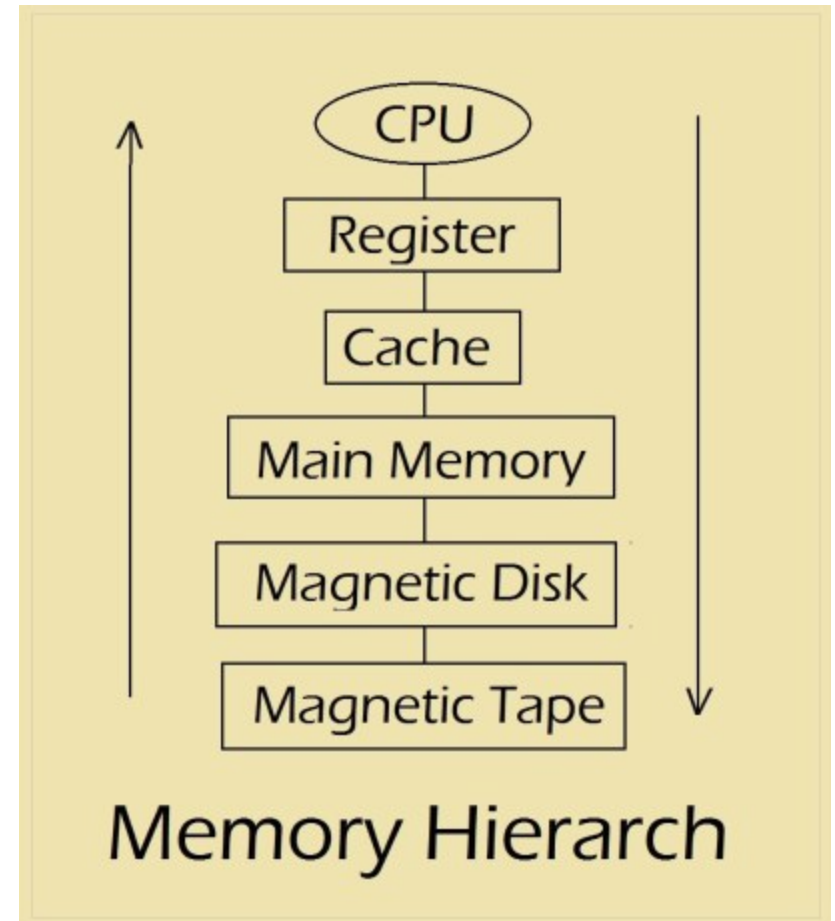
Cache Memory

- Cache memory is a small, fast and expensive memory that stores the copies of data that needs to be accessed frequently from the main memory.

Memory Hierarchy

The memory is characterized on the basis of two key factors; capacity and access time. The lesser the access time, the faster is the speed of memory.

The computer uses a hierarchy of memory that is organized in a manner to enable the fastest speed and largest capacity of memory as shown in figure.



Registers

- This is a part of CPU used for few special purpose such as temporary storage. The instruction data that currently going to be used are hold here that make it high speed memory location.

Internal Communications

- The internal communication of a processor in the computer system can be divided into two major categories:
 - (1) Processor to memory communication
 - (2) Processor to I/O devices communication

Machine Cycle

- The cycle during which a machine language instruction is executed by the processor of the computer system is known as machine cycle.

Instruction Cycle

- **Fetching:** The CPU retrieves the instruction from the main memory of the computer system.
- **Decoding:** Breaking down the instruction into different parts, so that it can be easily understood before being processed by the CPU.

Execution Cycle

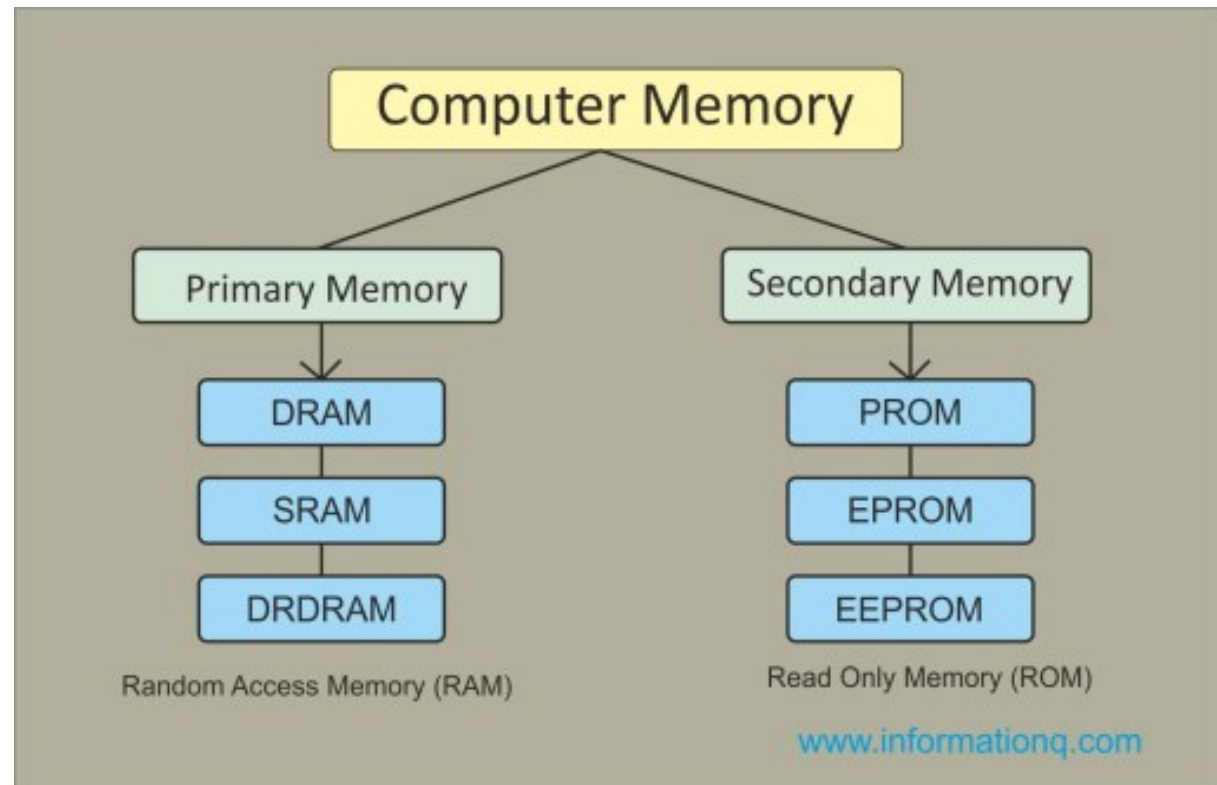
- **Executing:** The decoded instruction is executed by the ALU of the CPU.
- **Storing:** The result computed in the execution phase is either sent to the memory or to an output device.

The Bus

- A bus is a set of wires that is used to connect the different internal components of the computer system for the purpose of transferring data as well addresses amongst them.
- **Data bus:** used to transfer data amongst the different internal components. Modern computer systems use 32-bit data buses for data transfer.
- **Address bus:** transfers the memory addresses for read and write memory operations.

Computer Memory

Memory is major part of computers that categories into several types. Memory is best storage part to the computer users to save information, programs and etc, The computer memory offer several kinds of storage media some of them can store data temporarily and some them can store permanently. Memory consists of instructions and the data saved into computer through Central Processing Unit (CPU).



Memory and Storage Systems

- **Primary Memory:** Storing the data that are being currently handled by the CPU; generally known as “memory”;
- **Secondary Memory:** Storing the results and the data for future use; generally known as “storage”;
- **Internal Process Memory:** Placed either inside the CPU or near the CPU.

Memory Representation

- In the memory, values are represented by sequences of binary digits, known as bits. Most computers use a group of eight bits, known as a byte, to represent a character.
- Memory is a “bunch” of bytes or cells into which we can place data. Each cell, known as a data item, is assigned a unique number known as “address”. The CPU can identify each cell by its address.
- The byte is defined as the “smallest addressable unit” of memory. Most computers use groups of bytes, usually 2 or 4, known as “words” to represent information.
- Computer memories are often rated in terms of their capacity to store information. Typically, capacities are described using the unit of byte as follows:
 - (1) 1 KB (Kilobyte)=1,024 bytes
 - (2) 1 MB (Megabyte)=1,048,576 bytes
 - (3) 1 GB (Gigabyte)=1,073,741,824 bytes
 - (4) 1 TB (Terabyte)=1,099,511,627,776 bytes

Random Access Memory

- Random Access Memory (RAM) is a volatile memory and loses all its data when the power is switched off.
- It is the main memory of the computer system that stores the data temporarily and allows the data to be accessed in any order.
- RAM can be categorized into two main types, namely, Static RAM and Dynamic RAM.

Random Access Memory

- **Static RAM:** is a type of RAM in which data is stored till the power of the computer system is switched on. SRAM uses a number of transistors to store a single bit of digital information.
- **Dynamic RAM:** is the RAM in which data is stored in a storage cell, consisting of a transistor and a capacitor. The DRAM needs to be continuously refreshed with power supply because the capacitor has the tendency to get discharged. DRAM retains the data for a very short span of time, even after the power supply is switched off.

Read Only Memory

- ROM is the memory that stores the data permanently.
- The data can be easily read from this type of memory but cannot be changed.
- ROM is most commonly used in devices such as calculators, laser printers, etc.
- ROM does not allow the random access of data, and allows sequential access of data.

Read Only Memory

ROM is divided into four types:

- (1) **Programmable ROM:** a memory chip on which the write operation of data can be performed only once. PROM is reliable and stores the data permanently without making any change in it. It is mostly used in video games and electronic dictionaries.
- (2) **Erasable PROM:** a type of ROM in which data can be erased or destroyed using Ultraviolet Light.
- (3) **Electrically Erasable PROM:** a type of ROM in which data can be erased or destroyed by exposing it to an electric charge.
- (4) **Flash ROM:** a type of EEPROM that stores the information using floating-gate transistors, which can store electric charge for a longer period of time as compared to the normal transistors. This memory is mainly used in the memory cards of mobile phones, digital cameras and ipods for storing data. Flash ROM has faster speed of reading data, as compared to any other type of ROM.

Storage Systems

- Storage systems are the devices used for data storage. The main objective of the storage system is to permanently store data. The storage systems can be classified as follows:

(1) Magnetic

(2) Optical

(3) Solid state

(4) Magneto Optical

Magnetic Storage Systems

- Magnetic storage systems can be defined as the storage systems that store the data on a magnetised medium, with the help of magnetised particles. Magnetic tapes, magnetic disks, hard disks, floppy disks are examples of magnetic storage systems.
- Can store any type of data, such as text, audio, video, image

Optical Storage Systems

- The optical storage systems use the laser light as the optical medium to retrieve as well as record data.
- The optical storage devices are either read-only or writable.

Solid-State Storage Devices

- Solid-state Storage Devices were developed in 1978 by Storage Tek Company.
- Do not use magnetic and optical medium to store data. Instead, use the semiconductor devices.
- Contains all the properties of hard disk drives to store the data and use solid-state memory, which has no moving parts.
- The examples of SSD are flash memory cards and Universal Serial Bus (USB) devices.

Input Devices

- Input devices are electromechanical devices that are used to provide data to a computer for storing and further processing, if necessary.

- (1) Keyboard
- (2) Pointing devices
- (3) Scanning devices
- (4) Optical recognition devices
- (5) Digital camera
- (6) Voice recognition devices
- (7) Media input devices

The Input Devices of Computer

✓ Keyboard



✓ Mouse



✓ Scanner



✓ Trackball



✓ Joystick



✓ LightPen



✓ Touchscreens



✓ Optical Card Reader (OCR)

✓ Magnetic Ink Character Recognition (MICR)

✓ Optical Bar Code Reader (OBR)

✓ Voice Recognition Devices

✓ Optical Mark Reader (OMR)



Output Devices

Output devices receive the processed data (information) from the CPU and present it to the user in a desired form. They act as an interface between the computer and the user. The main task of an output device is to convert the machine readable information into human-readable form which may be in the form of text, graphics, audio or video. Depending upon the form of output required, the output device may belong to one of the following categories:

- Display monitors
 - Printers
 - Plotters
 - Voice output systems
 - Projectors
- While the printers and plotters provide the physical form of output known as *hard copy*, the display monitors, voice output systems and projectors provide temporary output known as *soft copy*. Unlike hard copy, soft copy is not a permanent form of output.

Output Devices of Computer

- ✓ Monitors
- ✓ Monitors or LED Monitors
- ✓ Printers
- ✓ Speakers



- ✓ Headphones
- ✓ Sound Cards
- ✓ Plotters
- ✓ Projectors





Thank you