054CS101 COMPUTER FUNDAMENTALS

UNIT – I : Computer Generation: First Generation of Computers - The Second Generation - The Third Generation - The fourth Generation - The Fifth Generation - Classification of Computers: Distributed Computer System - Parallel Computers - Block Diagram: Input-output devices - Description of Computer Input Units - Other Input Methods and Computer Output Units.

The Evolution of Computers:

- ✓ The first mechanical adding machine was invented by Blaise Pascal in 1642.
- ✓ Later, in the year 1671, Baron Gottfried Wilhelm von Leibniz of Germany invented the first calculator for multiplication.
- ✓ Keyboard machines originated in the United States around 1880 and are extensively used even today. Around this period only, Hermen Hollerith came up with the concept of punched cards, which were extensively used as input medium in computers even in late 1970s.
- ✓ Business machines and calculators made their appearance in Europe and America towards the end of the nineteenth century.

Charles Babbage, a nineteenth century Professor at Cambridge University, is considered the father of modern digital computers. During his period, mathematical and statistical tables were prepared by a group of clerks. Even the utmost care and precautions could not eliminate human errors.

Charles Babbage

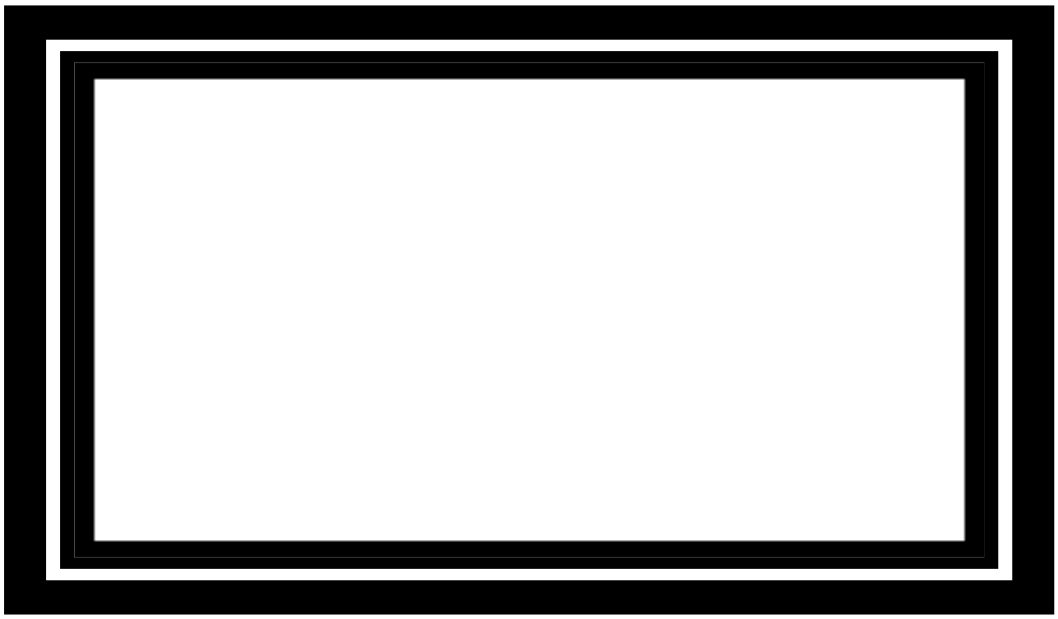
Babbage had to spend several hours checking these tables. Soon he became dissatisfied and exasperated with this type of monotonous job. The result was that he started thinking to build a machine, which could compute tables guaranteed to be error free. In this process, Babbage designed a "Difference Engine" in the year 1822, which could produce reliable tables. In 1842, Babbage came out with his new idea of Analytical Engine, which was intended to be completely automatic. It was to be capable of performing the basic arithmetic functions for any mathematical problem.

1. The Mark I Computer(1937-44): Also known as **Automatic Sequence Controlled calculator**, this was the first fully automatic calculating machine designed by Howard A.Aiken of Harvard University, in collaboration with IBM(International Business Machines)Corporation. Its design was based on the techniques already developed for punched card machinery. It was an electro-mechanical device, since both mechanical and electronic components were used in its design.

2. The Atanasoff-Berry Computer (1939-42).This **electronic machine** was developed by Dr.John Atanasoff to solve certain mathematical equations. It was called the **Atanasoff-Berry Computer**, or ABC, after its inventor's name and his assistant, Clifford Berry. It used 45 vacuum tubes for internal logic and capacitors for storage.

3. The ENIAC (1943-46). The **Electronic Numerical Integrator And Calculator** (ENIAC) was the **first all electronic computer**. It was constructed at the Moore School of Engineering of the University of Pennsylvania.U.S.A by a design team led by Professors J.Presper Eckert and John Mauchly.

ENIAC



ENIAC was **developed because of military need**, and was used for many years to solve ballistic problems. It took up the wall space in a 20 X 40 square feet room and used 18,000 vacuum tubes. The addition of two numbers was achieved in 200 microseconds, and multiplication in 2000 microseconds.

4. The EDVAC (1946-52): A major drawback of ENIAC was that its programs were wired on boards, which made it difficult to change the programs. This problem was later overcome by the "stored program" concept introduced by Dr.john Von Neumann.

The basic idea behind this concept is that a sequence of instructions, as well as data, can be stored in the memory of the computer, for automatically directing the flow of operations. This feature considerably influenced the development of modern digital computers because of the ease with which different programs can be loaded and executed on the same computer. Due to this feature, we often refer to modern digital computers as stored program digital computers.
The **EDVAC was designed on stored program concept.** Von Neumann also has a share of the credit for introducing the idea of storing both instructions and data in the binary form (a system that uses only two digits-0 & 1 to represent all characters), instead of the decimal numbers or human readable words.

5. The EDSAC (1947-49): Almost simultaneously with EDVAC of U.S.A, the Britishers developed the **Electronic Delay Storage Automatic Calculator** (EDSAC). The machine executed its first program in May 1949. In this machine, **addition operation was accomplished in 1500 microseconds**, and **multiplication operation in 4000 microseconds**. The machine was developed by a group of scientists, headed by Professor Maurice Wilkes, at the Cambridge University Mathematical Laboratory.

6. The UNIVAC I (1951): The **Universal Automatic Computer** (UNIVAC) was the **first digital computer**. Which was not "one of a kind", Many UNIVAC machines were produced, the first of which was installed in the Census Bureau in 1951 and was used continuously for 10 years. The first business use of a computer, a UNIVAC I, was by General Electric Corporation in 1954. In 1952, the International Business Machines (IBM) Corporation introduced the 701 commercial computers.
In rapid succession, improved models of the UNIVAC I and other 700-series machines were introduced. In 1953, IBM produced the IBM-650, and sold over 1000 of these computers. **The commercially available digital computers, which could be used for business and scientific applications**, had arrived.

The Computer Generations

"Generation" in computer talk is a step in technology. **It provides a framework for the growth of the computer industry**. Originally, the term "generation" was used to distinguish between varying hardware technologies. However, nowadays; it has been extended to include both hardware and software, which together make up an entire computer system.

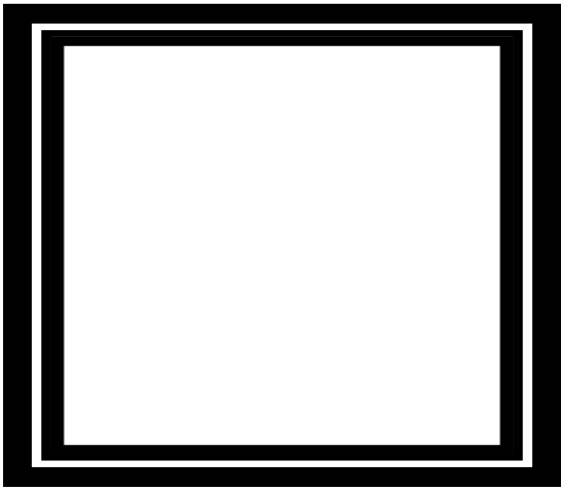
The custom of referring to the computer era in terms of generations came in to wide use only after 1964. There are totally five computer generations known until today. Each generation has been discussed below in detail along with its identifying characteristics.

Although there is a certain amount of overlapping between the generations, the approximate dates shown against each are normally accepted.

First Generation (1942-1955)

We have already discussed about some of the early computers – ENIAC, EDVAC, EDSAC, UNIVAC I. and IBM 701.These machines and others of their time were **built by using thousands of vacuum tubes**. A vacuum tube was a fragile glass device, which used filaments as a source of electronics, and could control and amplify electronic signals. It was the only high-speed electronic switching device available in those days. These vacuum tube computers could perform computations in milliseconds, and were referred to as first generation computers.

VACUUM TUBES



The memory of these computers was constructed using electromagnetic relays, and all data and instructions were fed in to the system from punched cards. **The instructions were written in machine and assembly languages** because high level programming languages were introduced much later. Because machine and assembly languages are very difficult to work with, only a few specialists understood how to program these early computers.

The characteristic features of first-generation computers are as follows:

1. They were the fastest calculating devices of their time.
2. They were **too bulky in size**, requiring large rooms for installation.
3. Thousands of vacuum tubes, which were used, emitted large amount of heat and burnt out frequently. Hence, the rooms/areas in which these computers were located had to be properly **air-conditioned**.
4. Each vacuum tube consumed about half a watt of power. Since a computer typically used more than ten thousand vacuum tubes, **the power consumption of these computers were very high**.

5. As vacuum tubes used filaments, they had a limited life. Since thousands of vacuum tubes were used in making one computer, these computers were prone to **frequent hardware failures.**

6. Due to low mean time between failures, these computers required almost constant maintenance.
7. In these computers, thousands of individual components had to be assembled manually by hand in to functioning circuits .Hence, **commercial production of these computers were difficult and costly**.
8. Since these computers were **difficult to program and use**, they had limited commercial to use.

Second Generation (1955 – 1964)

A new electronic switching device, called **transistor** was invented at bell Laboratories in 1947 by john Bardeen, Willian Shockley, and Walter Brattain.

TRANSISTOR

Transistors soon proved to be a better electronic switching device than the vacuum tubes, due to their following properties:

1. They were more rugged and easier to handle than tubes, since they were **made of germanium semiconductor material** rather than glass.
2. They were **highly reliable** as compared to tubes, since they had no part like a filament, which could burn out.
3. They could **switch much faster** (almost ten times faster) **than tubes**. Hence, switching circuits made of transistors could operate much faster than their counterparts made of tubes.
4. They consumed almost one-tenth the power consumed by a tube.
5. They were much **smaller than a tube**.
6. They were **less expensive** to produce.
7. They **dissipated much less heat** as compared to vacuum tubes.

The second generation computers were manufactured using transistors, instead of vacuum tubes. Due to the properties of transistors listed above, the second generation computers were more powerful, more reliable, less expensive, smaller, and cooler to operate than the first generation computers.

The **memory of the second-generation computers was composed of magnetic cores**. Magnetic disk and magnetic tape were the main secondary storage media used in second generation computers. Punched cards were still popular and widely used for preparing programs and data to be fed to these computers.

The characteristics features of second generation computers are as follows:

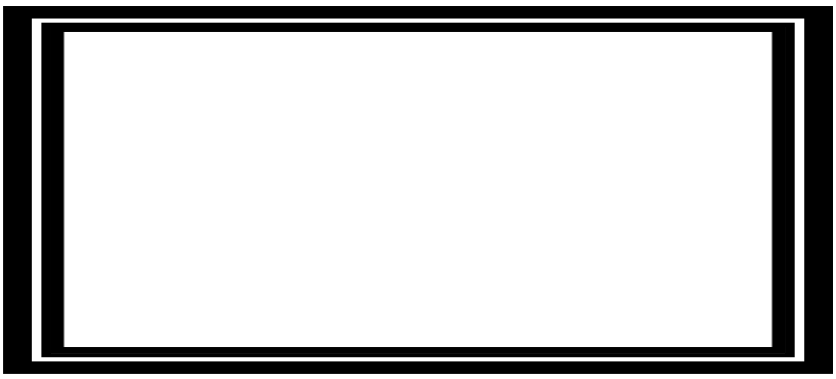
1. They were **more than ten times faster** than the first generation computers.
2. They were much smaller than first generation computers, **requiring smaller space**.
3. Although the **heat dissipation was much less** than first generation computers. The rooms/areas in which the second generation computers were located had to be properly **air-conditioned**.
4. They **consumed much less power** than the first generation computers.
5. They were **more reliable and less prone to hardware failures** than the first generation computers.
6. They had **faster and larger primary and secondary storage** as compared to first Generation computers
7. They were much easier to program and use than the first generation computers. Hence, they had wider commercial use.
8. In these computers, thousands of individual transistors had to be assembled manually by hand in to functioning circuits. Hence, commercial production of these computers were difficult and costly.

Third Generation (1959-1971)

Although transistors were great deal of improvement over the vacuum tubes, they generated the heat and damaged the areas of the computer.

The **Integrated Circuit(IC)** was invented in 1958 by jack Kilby. It combined electronic components on to a small silicon disc, made from quartz. More advancement made possible the fitting of even more components on a small chip or a semi conductor. Also in third generation computers, the operating system allowed the machines to run many different applications.

INTEGRATED CIRCUIT(IC)



These applications were monitored and coordinated by the computers memory:

- **1959** – Jack kilby of Texas instruments patented the first integrated circuit in Feb1959; Kilby had made his first germanium IC in Oct1958. Robert Noycee at Fairchild used planer process to make connections of components within a silicon IC in early 1959. The first commercial product using IC was hearing aid in Dec, 1963. General instrument made LSI chip (100+ components) for hammand organ 1968.
- **1964** – IBM product SABRE ,The first airline reservation tracking system for American airlines, IBM announced the system/360 all purpose computer ,using 8 bit character word length(a "Byte") that was pioneered in the 7030 of April 1961 that grew out of the AF contract of Oct.1958 following Sputnik to develop transistor computers for BMEWS.
- **1968** – DEC introduced the first "mini computer", the PDP-8,named after the mini skirt,Dec was founded in1957 by Kenneth Holsen who came for the SAGE project at MIT and began sales of the PDP-1 in 1960.
- **1969** – Development began on ARPANET, founded by the DOD.
- **1971** – Intel produced large scale integrated (LSI) circuits that were used in the digital delay line, the first digital audio device.

Fourth Generation Computers: (1971-Present)

Fourth Generation Computers are the modern day computers .The size started to go down with the improvement in the integrated circuits. Very Large Scale (VLSI) and Ultra Large Scale (ULSI) ensured that **millions of components could be fit in to a small chip**. **It reduced the size and price of the computers at the same time increasing the power, efficiency and reliability**.

The Intel 4004 chip developed in 1971, took the integrated circuit one step further by locating all the components of a computer (central processing unit, memory and input, output controls) on a minuscule chip.

Due to the reduction of cost and the availability of the computers power of a small place allowed everyday user to benefit. First, the **mini computers came** which offered user's

different applications, most famous of these the **word processors and spreadsheet** which could be used by non technical users. **Video game system** like Atari 2600 generated the interest of general populace in the computers.

- ✓ **In 1981, IBM introduced personal computers for home and office use**. The number of personal computers in use more than doubled from two million in 1981 to 5.5 million in 1982. Ten years later, 65 million PCs were used. **Computer size kept getting reduced during the years.** It went down from **Desktop to laptops to Palmtops**. Macintosh introduced Graphical user interface in which the user didn't have to type instructions. But could use mouse for the purpose.
  The continued improvement allowed the **networking of computers** for the sharing of data. Local area Network (**LAN**) and Wide Area Network (**WAN**) were potential benefits, in that they could be implemented in corporations and everybody could share data over it. Soon the internet and world wide appeared on the computer scene and formatted the high Tech revolutions of 90's.

- ✓ **1971 – Hyatt at micro computer co. patented the microprocessor**. Ted Hoff at Intel in Feb introduced the 4 bit 4004, a VLSI of 2300 components, for the Japanese company Busicom to create a single ship for a calculator.
  IBM introduced the first 8-inch "memory disk", as it was called then, or the "floppy disk" later. Hoffmann la roche patented the passive LCD display for calculators and watches, In Nov Intel announced the first micro computer, the MCS-4, Nolan Bushnell designed the first commercial arcade video game "Computer space".

- ✓ **1972 – Intel made the 8-bit 8008 and 8080 microprocessors**, Gary Kildall wrote his control program or microprocessor (CP/M) disk operating system to provide instructions for floppy disk drives to work with the 8080 processor. He offered it to Intel, but was turned down. So he sold it on his own, and soon CP/M was the standard OS for 8 bit microcomputer.

Fifth Generation Computers (Present and Beyond)

First Generations computers are only in the minds of advance research scientist and being tested out in the laboratories. These computers will be under Artificial Intelligence (AI).They will be able to take commands in an audio visual way and carry out instructions. Many of the operations which require low human intelligence will be performed by these computers.

Parallel processing is coming and showing the possibility that the power of many CPU's can be used side by side, and computers will be more powerful than those under

central processing. Advances in super conductor technology will greatly improve the speed of information traffic. Futures look bright for the computers.

- **1991 – WWW (World Wide Web)** was developed by Tim Berners-Lee and released by CERN.
- **1993 – The first Web Browser called Mosaic** was created by student Marc Andreessen and programmer Eric Bina at NCSA in the first three months of 1993.
- **1994 – Netscape Navigator 1.0** was released 1994.
- 1996 - Microsoft failed to recognize the importance of the Web. But finally released the much improved Browser explorer.

Classification of Computers

The computers are categorized in to the following types:

1. Notebook Computers.
2. Personal Computers.
3. Workstation.
4. Mainframe systems.
5. Super computers.

Notebook Computers:

Notebook computers are **portable computers**, which are mainly meant for use by people who computing need power wherever they go.
As the name implies, notebook computers are approximately of the size of an 8(1/2) X 11 inch notebook, and **can easily fit inside a briefcase**. Since they have to be carried along, they are also light in weight, weighting around 2Kg. They are also known as **laptop** PCs (laptop personal computers), because they are as powerful as a PC, and their size and weight allows them to be used by comfortably placing them on ones lap.

A notebook computer uses an almost full-size keyboard, a small flat screen liquid crystal color display, and a trackball(instead of a mouse, because notebook computers are often used without a desk).They also have a hard disk, a floppy disk drive, and a CD-ROM drive. The display screen is foldable in a manner that, when not in use, it can be folded to flush with the keyboard, to convert the system in to notebook form. When in use, the display screen is folded open.

Many models of notebook computers can be plugged into a “dock” on a docking station (a personal computer or a workstation), to take advantage of the larger machines big monitor, storage space, and other peripherals, such as a printer. Many models of notebook computers

can also be connected to a network, to enable them to download data (read files) from other computers on the network.

Personal Computers (PCS):

Personal computers are desktop computers designed for an individual's use. They run programs designed to help individuals accomplish their work more productively.

A PC is **a non-portable, general-purpose computer**, which can easily fit on a normal size office table. PCs are found on the working desks of several employees, in any organizations. PCs are also providing employees with flexible working environments. Those employees, who could not work during traditional office hours due to personal reasons, can now work part of the time in the office and the remainder of the time at home, by having a PC in their homes. PCs are now very common everywhere, and can be found in offices, classrooms, homes, hospitals, shops, clinics, etc.

Workstations:

A **workstation** is a powerful Desktop computer designed for technical or scientific applications. Intended primarily to be used by one person at a time, they are commonly connected to a local area network and run multi-user operating systems. The term *workstation* has also been used to refer to a PC connected to a network.

Workstation

The characteristic features of workstation are:

1. **Processing Power:** The Processing Power of a workstation is several times more than that of an average power of a PC.
2. **Storage capacity:** Workstations have larger main memory (typically 0.5 GB to a few GB) as compared to PCs, which have few tens or hundreds of MB of main memory. The hard disk capacity of a workstation is also much more.

3. **Display Facility:** Most Workstations have a large screen (21 inch or more) monitor capable of displaying high-resolution graphics.
4. **Processor design:** PCs normally use CPUs based on CISC technology, whereas workstations use CPUs based on RISC technology. Popular RISC processors used in workstations are ALPHA.
5. **Operating System:** Unlike PCs which can run any of the five major OSs – MS-DOS, MS windows, Windows-NT.
6. **Network interface card:** Most Workstations have built-in hardware to connect to a LAN.

Mainframe Systems:

There are several organizations such as banks, insurance companies, hospitals, railways, etc. that need on-line processing of large number of transactions, and require computer systems, which have massive data storage and processing capabilities. Mainframe systems are computer systems.

A typical configuration of a mainframe system consists of the following components:

1. Host, front-end, and back-end computers.
2. Console(s).
3. Storage devices.
4. User terminals.
5. Output devices.

Main Frame Computer

Supercomputers:

Supercomputers are the most powerful and expensive computers available at a given time. They are primarily used for processing complex scientific applications, which require enormous processing power.

Some of the supercomputing applications are as follows:

1. Aerospace industry.
2. Petroleum industry
3. Automobile industry.

4. Structural mechanics industry
5. Meteorological centers.

Super Computer

Petroleum industry uses super computers to analyze volumes of seismic data, which are gathered during oil-seeking explorations, to identify areas where there is possibility of getting petroleum products inside the earth.

Distributed Computer System

A distributed computing system is a configuration in which many independent computer systems are connected by a communication network, and in which messages, processing task, programs, data, and other resources are transmitted between cooperating computer systems. Such as arrangement enables the sharing of many hardware and software resources, as well as information, among several users who may be sitting for away from each other.

It also increases the usability of computers by bringing them closer to the end users, and integrating them into daily business activities at the locations at which these activities take place. The individual computers of a distributed computing system are often referred to as nodes. It is obvious that distributed computing systems are much more complex and difficult to build than traditional centralized systems.

The increased complexity is mainly due to the following reasons:

1. The system must be designed in a manner to effectively use and manage a very large number of distributed resources.

2. The system must be designed to enable communication among the various nodes of

the system. Special software is usually needed to handle loss of messages during transmission across the network.

3. Special security measures are needed to protect the widely distributed shared resources and services against intentional.

Despite the increased complexity and the difficulty of building distributed computing systems, the installation and use of distributed computing system is rapidly increasing. This is mainly because the advantages of distributed computing systems outweigh their disadvantages.

The major advantages of distributed computing systems are as follows:

1. **Inherently distributed applications:**
   Several applications require a distributed computing system for their realization. A few examples of such applications are electronic mail facility, a computerized worldwide airline reservation system, and a computerized banking system in which a customer can deposit/withdraw money from his or her account from any branch of the bank.

2. **Information sharing among distributed users:**
   In a distributed computing system, information generated by one of the users can be easily and efficiently shared by the users working at other nodes of the system. For example ,a project can be performed by two or more users who are geographically far off from each other, but whose computers are part of the same distributed computing system ,In this case ,although the users are geographically separated from each other, they can work in cooperation.

3. **Resource sharing:**
   Information is not the only thing that can be shared in a distributed computing system, Sharing of software resources, such as software libraries and databases, as well as hardware resources, such as printers, hard disks, and plotters can also be done in a very effective way among all the computers and the users of a single distributed computing system.

4. **Shorter response times and higher throughput:**
   Multiple processors of a distributed computing system can be utilized properly for providing shorter response times and higher throughput than a single processor centralized system.

5. **Higher reliability:**
   A reliable system prevents loss of information even in the event of component failures. The multiplicity of storage devices and processors in a distributed computing system allows the maintenance of multiple copies of critical information within the system, and the execution of important computation redundantly to protect them against catatrophic failures. With this approach, if one of the processors fails, the computation can be successfully completed at the other processor, and if one of the storage devices fails, the information can still be used from the other storage devices.

6. **Extensibility and incremental growth:**
   It is possible to gradually extend the power and functionality of a distributed computing system by simply adding additional resources to the system, as and when the need arises.

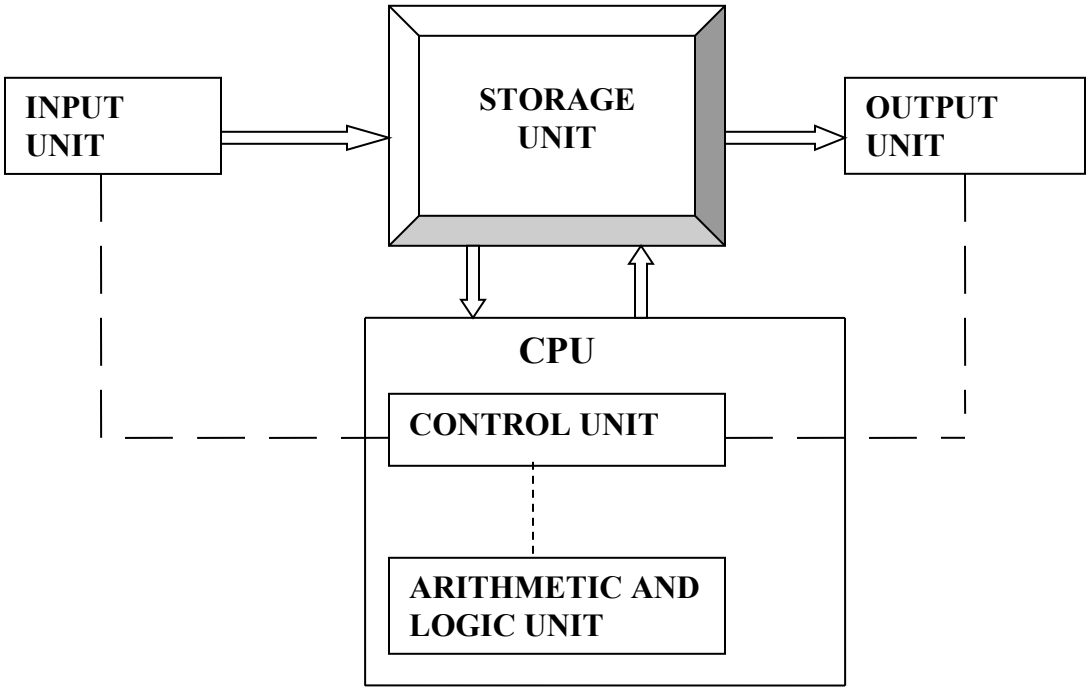
7. **Better flexibility in meeting users needs:**
   Different types of computers are usually more suitable for performing different types of computations.

Parallel computers:

Parallel computing is a form of computation in which many instructions are carried out simultaneously, operating on the principle that large problems can often be divided into smaller ones, which are then solved concurrently ("in parallel"). There are several different forms of parallel computing.

Parallel computers can be roughly classified according to the level at which the hardware supports parallelism—with multi-core(A **multi-core** processor is a processing system composed of two or more independent cores (or CPUs).) and multi-processor computers having multiple processing elements within a single machine.

Block Diagram: Input-output devices



Input unit

Data and instructions must enter the computer system, before any computation can be performed on the supplied data. This task is performed by the input unit, which links the external environment with the computer system. Data and instructions enter input units in forms, which depend upon the particular device used.

The following functions are performed by an input unit:

1. It accepts (or reads) the instructions and data from the outside world.
2. It converts these instructions and data in computer acceptable form.
3. It supplies the converted instructions and data to the computer system for further processing.

Input devices are: Keyboard, Scanner, Digital Camera etc.

Output unit

The job of an output unit is just the reverse of that of an input Unit., It supplies the information obtained from data processing, to the outside world. Hence it links the computer with the external environment's computers work with binary code; the results produced are also in the binary form. Hence, before supplying the results to the outside world, they must be converted to human acceptable (readable) form. This task is accomplished by units called output interfaces. Output interfaces are designed to match the

unique physical or electrical characteristics of output devices to the requirements of the external environment.

The following functions are performed by an output unit:

1. It accepts the results produced by the computer, which are in coded form, and hence cannot be easily understood by us.
2. It converts these coded results to human acceptable form
3. It supplies the converted results to the outside world

Output devices are: Monitor, Printers, and Speakers.

Storage unit:

The process of saving data and instructions (commands) permanently is known as storage (secondary, primary storage). Storage Device: Hard drive, Floppy drive, CD drive.

Primary storage:

The primary storage, also known as main memory is used to hold pieces of program instructions and data intermediate results of processing and recently produced results of processing. The primary storage of modern computer systems is made up of semiconductor devices.

Secondary storage:

The secondary storage also known as auxiliary storage is used to take care of the limitations of the primary storage. That is it is used to supplement the limited storage capacity and the volatile characteristic of primary storage. The most commonly used secondary storage medium is the magnetic disk.

Arithmetic logic unit

The arithmetic logic unit (ALU) of a computer system is the place, where the actual execution of the instructions takes place, during the processing operation. To be more precise, calculations are performed, and all comparisons are made in the ALU. The data and instructions, stored in the primary storage before processing are transferred as and when needs to the ALU, where processing takes place, No processing is done in the primary storage unit.

Control unit

How does the input device know that it is time for it to feed data in to the storage unit? How does the ALU know, what should be done with the data once they are received? Moreover, how is it that only the final results are sent to the output device, and not the intermediate results? All this is possible due to the control unit of the computer system. Although, it does not perform any actual processing on the data, the control unit acts as a central nervous system, for the other components of the computer system.

Central processing unit

The control unit and the arithmetic logic unit of a computer system are jointly known as the Central processing unit (CPU).The CPU is the brain of a computer system. In a human body, all major decisions are taken by the brain, and the other parts of the body function as directed by the brain. Similarly, in a computer system, all major calculations and comparisons are made inside the CPU, and the CPU is responsible for activating and controlling the operations of other units of the computer system.