Unit-1

Computer Basics

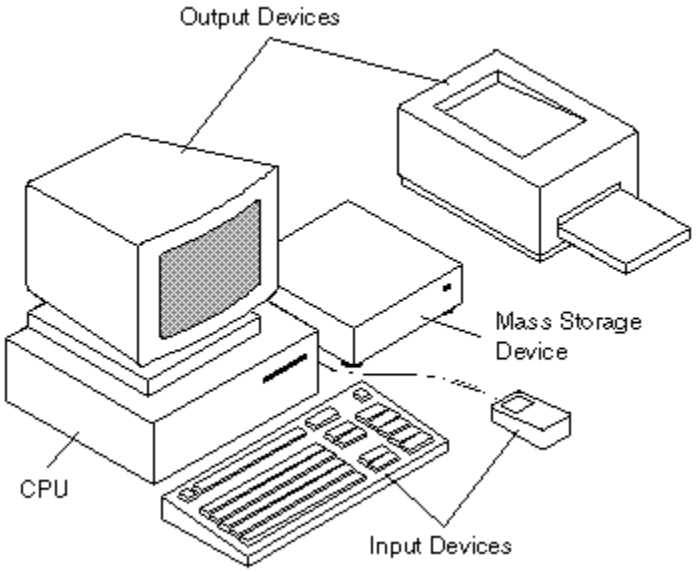
1.1 Computer:

Computer is an electronic device, which is used for manipulating data according to a list of instructions. A list of computer instructions designed to perform some task is known as a program. It is a complete collection of hardware, software and peripherals designed to work together. Computers take numerous physical forms. Early electronic computers were the size of a large room, consuming as much power as several hundred modern personal computers. Today, computers can be made small enough to fit into a wrist watch and powered from a watch battery. the most common form of computer in use today is by far the embedded computer. Embedded computers are mostly small and simple and they are often used to control other devices. They are used to control machines from fighter aircraft to industrial robots, digital cameras, and even children's toys.
The defining feature of modern computers which distinguishes them from all other machines is that they can be programmed. That is to say that a list of instructions can be given to the computer and it will store them and carry them out at some time in the future. Instruction is a command given to a computer to perform specified task. Some computer instructions are simple: add one number to another, move some data from one location to another, send a message to some external device, etc. These instructions are read from the computer's memory and are generally executed in the order they were given.

Computer works mostly on data and information. Data is a collection of raw facts. Data may be valuable or non-valuable. When these data has been converted and processed, so that it gets definite form and shape which becomes useful and act as a base for making any decision. Then it becomes an information, in simple we can say that information is the processed data. The two principal characteristics of a computer are:

- It responds to a specific set of instructions in a well-defined manner.
- It can execute a prerecorded list of instructions.

Modern computers are electronic and digital. The actual machinery i.e. wires, transistors, and circuit is called hardware. The instructions and data are called software. All general-purpose computers require the following hardware components as shown in the diag:



- **memory**: Enables a computer to store, at least temporarily, data and programs.
- **mass storage device :** Allows a computer to permanently retain large amounts of data. Common mass storage devices include disk drives and tape drives.
- **input device :** Usually a keyboard and mouse, the input device is the way through which data and instructions enter a computer.
- **output device :** A display screen, printer, or other device that lets you see what the computer has accomplished.
- **central processing unit (CPU):** The heart of the computer, this is the component that actually executes instructions.

Computer System mainly consists of two things:

Hardware: The term hardware covers all of those parts of a computer that are tangible objects. Circuits, displays, power supplies, cables, keyboards, printers and mice are all hardware.

Software: Software refers to parts of the computer that have no material form; programs, data, protocols, etc are all software. When software is stored in hardware that cannot easily be modified (such as BIOS ROM in an IBM PC compatible), it is sometimes termed firmware to indicate that it falls into an area of uncertainty between hardware and software.

1.2 Characteristics Of Computer

Speed: The smallest unit of time that we know is second, But the measurement of operations in computers are in microsecond, nanosecond and pico second. The speed of computer is closely related to the amount of data it process. The term volume and frequency are often used to describe the amount of data. Volume represent the overall quantity of the data to be processed. Frequency specifies how often a specific data item is used in processing.

Accuracy: Human Beings make certain mistakes while doing certain computation. But the computer system computes the data accurately and quickly.

Reliability: Computer systems are widely accepted because of their exceptional reliability. Unlike, most humans, they are capable of doing the work under the most adverse condition without showing any sign of fatique. Computer provides the accurate result under all the operating conditions.

Storage Capability: Computer system has a storage area which is known as memory to hold a large amount of data. The installation of computer has meant economic survival for many companies.

Versatility: Computers are versatile. They can do a variety of jobs depending on the instruction fed to them and their hardware characteristics. Modern computers are capable of handling not only complex arithmetic problems but also a lots of job unrelated to numbers, like railways and airline ticket reservation. Computers can be attached with several kinds of peripheral devices to accomplish variety of jobs.

Even computer system has got thousand of advantages but there are some disadvantages also that it does not take any decision o their own because it is working on the basis of what are feed in it. It's Iq is completely zero.

Beside many advantages the computer has also some of the disadvantages they are:

- Computer does no work by itself. It works on the basis of the list of instruction given to it.
- Computer does not have any I.Q it works on the basis of what has been instructed.
- Computer does not take decision of its own.
- Computer does not learn by experience.

1.3 History Of Computer:

The history of computers dates back to 500 BC, when the Chinese invented a calculating machine called Abacus. Some of these types of inventions discussed below are:

- Abacus
- Jacquard Loom

- Charles Babbage's Difference Engine
- Hollerith Census Tabulator
- Aiken & Mark1
- Von Neumann

A. Abacus

An **abacus** is a calculation tool, often constructed as a wooden frame with beads sliding on wires. It was in use centuries before the adoption of the written Hindu-Arabic numeral system and is still widely used by merchants and clerks in the People's Republic of China, Japan, Africa, and elsewhere.

The Chinese abacus is typically around 20 cm (8 inches) tall and it comes in various widths depending on the application. It usually has more than seven rods. There are two beads on each rod in the upper deck and five beads each in the bottom for both decimal and hexadecimal computation. The beads are usually rounded and made of a hard wood. The beads are counted by moving them up or down towards the beam. The abacus can be reset to the starting position instantly by a quick jerk along the horizontal axis to spin all the beads away from the horizontal beam at the center.

Chinese abaci can be used for functions other than counting. Unlike the simple counting board used in elementary schools, very efficient **suanpan** techniques have been developed to do multiplication, division, addition, subtraction, square root and cube root operations at high speed.

Bead arithmetic is the calculating technique used with various types of abaci, in particular the Chinese abacus. The similarity of the Roman abacus to the Chinese one suggests that one could have inspired the other, as there is some evidence of a trade relationship between the Roman Empire and China. However, no direct connection can be demonstrated, and the similarity of the abaci may be coincidental, both ultimately arising from counting with five fingers per hand. Where the Roman model (like most modern Japanese) has 4 plus 1 bead per decimal place, the standard Chinese abacus has 5 plus 2, allowing less challenging arithmetic algorithms, and also allowing use with a hexadecimal numeral system. Instead of running on wires as in the Chinese and Japanese models, the beads of Roman model runs in groves, presumably making arithmetic calculations much slower. Possibly the Roman abacus was used primarily for simple counting. In a contest between the Chinese abacus and the electric calculator on November 12, 1946, the abacus won 4 to 1.

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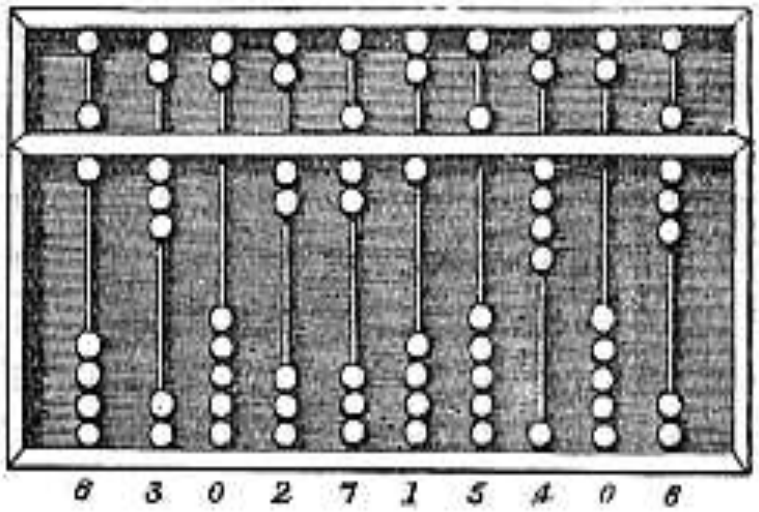


2. Jacquard's Loom

The **Jacquard loom** is a mechanical loom, invented by Joseph Marie Jacquard in 1801, which utilized holes punched in pasteboard, each row of which corresponded to one row of the design. Multiple rows of holes were punched on each card and the many cards that comprised the entire design of the textile were strung together in order.

Each hole in the card corresponds to a "Bolus" hook, which can either be up or down. The hook raises or lowers the harness which carries and guides the warp thread so that the weft will either lie above or below it. The sequence of raised and lowered threads is what creates the pattern. Each hook can be connected via the harness to a number of threads, allowing more than one repeat of a pattern. A loom with a 400 hook head might have four threads connected to each hook, resulting in a fabric that is 1600 warp ends wide with four repeats of the weave going across.

Charles Babbage Difference Engine

The first device that might be considered to be a computer in the modern sense of the word was conceived in 1822 by the eccentric British mathematician and inventor Charles Babbage.

Babbage's engines were among the first mechanical computers. His engines were not actually completed, largely because of funding problems and personality issues. Babbage realized that a machine could do the work better and more reliably than a human being. Babbage directed the building of some steam-powered machines that more or less did their job, suggesting calculations could be mechanized to an extent.

The data and program memory were separated, operation was instruction based, the control unit could make conditional jumps and the machine had a separate I/O unit.

In Babbage's time numerical tables were calculated by humans called 'computers'. At Cambridge he saw the high error rate of the people computing the tables and thus started his life's work in trying to calculate the tables mechanically, removing all human error. He began in 1822 with what he called the difference engine, made to compute values of polynomial functions.

Soon after the attempt at making the difference engine crumbled, Babbage started designing a different, more complex machine called the Analytical Engine. The engine is not a single physical machine but a succession of designs that he tinkered with until his death in 1871. The main difference between the two engines is that the Analytical Engine could be programmed using punch cards, an idea unheard of in his time.

Hollerith Census Tabulator

The US government began to encounter certain problem in data processing. It took seven years to compile the statistics from the 1880 census and it became apparent that it would be time to begin a new census before the analysis one was completed. Hollerith designed a device called the tabulating machine, which used machine readable punched cards. This card has round holes and forty five columns. His machine reduces the tabulating time to one-eighth the time required by the old methods.

Aiken & Mark1

The **IBM Automatic Sequence Controlled Calculator** (**ASCC**), called the **Mark I** by Harvard University[1], was the first large-scale automatic digital computer in the USA. It is considered by some to be the first universal calculator.

The electromechanical ASCC was devised by Howard H. Aiken, created at IBM, shipped to Harvard in February 1944, and formally delivered there on August 7, 1944. The main advantage of the Mark I was that it was fully automatic—it didn't need any human intervention once it started. It was the first fully automatic computer to be completed. It was also very reliable, much more so than early electronic computers. It is considered to be "the beginning of the era of the modern computer"

The building elements of the ASCC were switches, relays, rotating shafts, and clutches. It was built using 765,000 components and hundreds of miles of wire, amounting to a size of 51 feet (16 m) in length, eight feet (2.4 m) in height, and two feet deep. It had a weight of about 10,000 pounds (4500 kg). The basic calculating units had to be synchronized mechanically, so they were run by a 50 foot (15 m) shaft driven by a five-horsepower (4 kW) electric motor.

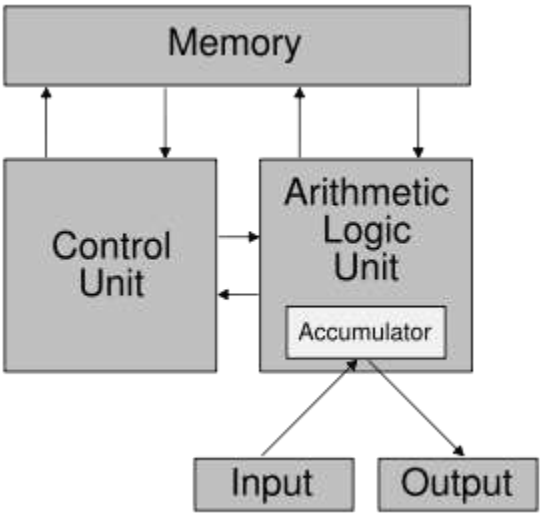
The Mark I could store 72 numbers, each 23 decimal digits long. It could do three additions or subtractions in a second. A multiplication took six seconds, a division took 15.3 seconds, and a logarithm or a trigonometric function took over one minute.

The Mark I read its instructions from a 24 channel punched paper tape and executed the current instruction and then read in the next one. It had no conditional branch instruction. This meant that complex programs had to be physically long. A loop was accomplished by joining the end of the paper tape containing the program back to the beginning of the tape.

1.4 Von Neuumann

The **von Neumann architecture** is a computer design model that uses a processing unit and a single separate storage structure to hold both instructions and data.

The separation between the CPU and memory leads to the von Neumann bottleneck, the limited throughput (data transfer rate) between the CPU and memory compared to the amount of memory. In modern machines, throughput is much smaller than the rate at which the CPU can work. This seriously limits the effective processing speed when the CPU is required to perform minimal processing on large amounts of data. The CPU is continuously forced to wait for vital data to be transferred to or from memory. As CPU speed and memory size have increased much faster than the throughput between them, the bottleneck has become more of a problem.



1.5 Technical Evolution Of Computer:

The term generation is used to characterise the major developments in the computer industry. There are five generations of computers and the term generation means we are able to distinguish between different hardware technologies.

- First Generation 1946-1956
- Second Generation 1956-1964
- Third Generation 1964-1971
- Fourth Generation 1971-Present
- Fifth Generation Present-Future

1.5.1 First Generation Computers

The era of the first generation computers began in 1946 because that was the year when people consciously set out to build stored program computers. In 1946 there was no 'best' way of storing instructions and data in a computer memory. There were four competing technologies for providing computer memory: electrostatic storage tubes, acoustic delay lines (mercury or nickel), magnetic drums (and disks), and magnetic core storage.

Electrostatic Storage tubes: A high-speed electrostatic store was the heart of several early computers. The great advantage of this type of "memory" is that, by suitably controlling the deflector plates of the cathode ray tube, it is possible to redirect the beam almost instantaneously to any part of the screen

Acoustic delay lines: It is based on the principle that electricity travels at the speed of light while mechanical vibrations travel at about the speed of sound. So data can be stored as a string of mechanical pulses circulating in a loop, through a delay line with its

output connected electrically back to its input. The sequence of bits flowing through the delay line is just a continuously repeating stream of pulses and spaces, so a separate source of regular clock pulses is needed to determine the boundaries between words in the stream and to regulate the use of the stream. Delay lines have some obvious drawbacks. One is that the match between their length and the speed of the pulses is critical, yet both are dependent on temperature. Another is a programming consideration. The data is available only at the instant it leaves the delay line. If it is not used then, it is not available again until all the other pulses have made their way through the line.

- A **mercury delay line** is a tube filled with mercury, with a piezo-electric crystal at each end. Piezo-electric crystals, such as quartz, have the special property that they expand or contract when the electrical voltage across the crystal faces is changed. Conversley, they generate a change in electrical voltage when they are deformed. So when a series of electrical pulses representing binary data is applied to the transmitting crystal at one end of the mercury tube, it is transformed into corresponding mechanical pressure waves. The waves travel through the mercury until they hit the receiving crystal at the far end of the tube, where the crystal transforms the mechanical vibrations back into the original electrical pulses. Mercury delay lines had been developed for data storage in radar applications.
- **Nickel delay lines** take the form of a nickel wire. Pulses of current representing bits of data are passed through a coil surrounding one end of the wire. A receiving coil at the other end of the wire is used to convert these pressure waves back into electrical pulses.

Magnetic Drum: The magnetic drum is a more familiar technology, comparable with modern magnetic discs. It consisted of a non-magnetic cylinder coated with a magnetic material, and an array of read/write heads to provide a set of parallel tracks of data round the circumference of the cylinder as it rotated. Drums had the same program optimization problem as delay lines.

Magnetic Core Memory: The most important contribution made by the MIT(Massachusetts Institute of Technology) group was the development of the magnetic core memory, which they later installed in Whirlwind. The MIT group made their core memory designs available to the computer industry .

BENDIX G-15 COMPUTER

Some computers of these generations are given below:

ENIAC: The first generation of computers is said by some to have started in 1946 with ENIAC, the first 'computer' to use electronic valves i.e. vacuum tubes. It is developed at the university of Pennsylvania in U.S.A by the team of Eckert and Mauchly. The full form of ENIAC is Electronic Numerical Integrator and Calculator. It has a very small memory and mostly used for calculating the trajectory of missiles.

EDVAC: The full form of EDVAC is Electronic discrete variable Automatic Computer. In this machine instruction of the program are stored with the data internally. By the help of this the accessing of computer becomes faster.

EDSAC: In May 1949 there is a introduction of EDSAC, the first stored program computer. EDSAC stands for Electronic Delay Storage Automatic Computer. It makes use of mercury delay lines for storage of data.

UNIVAC: The first commercial production of stored electronic computer was UNIVAC. UNIVAC stands for Universal Automatic Computer. Univac division of Remington Rand develops it.

Characteristics of First Generation Computers

- Used vaccum tubes
- Not reliable
- Big and clumsy computers
- Electric consumption is very high
- This type of computers generate too much heat, therefore air conditioners are required.
- Batch processing
- Slow Input/Output operations.

1.5.2 Second Generation Computers

The invention of Transistors marked the start of the second generation. These transistors took place of the vacuum tubes used in the first generation computers. First large-scale machines were made using these technologies to meet the requirements of atomic energy laboratories. One of the other benefits to the programming group was that the second generation replaced Machine language with the assembly language. Even though complex in itself Assembly language was much easier than the binary code.

Second generation computers also started showing the characteristics of modern day computers with utilities such as printers, disk storage and operating systems. Much financial information was processed using these computers.

In Second Generation computers, the instructions could be stored inside the computer's memory. High-level languages such as COBOL (Common Business-Oriented Language) and FORTRAN (Formula Translator) were used.

Characteristics of Second Generation Computers

- Transistor takes place of vaccum tubes.
- Faster than first generation.
- Assembly language is used instead of machine language.
- Generate less heat
- Smaller in size
- Magnetic tapes and disks are used.

1.5.3 Third Generation Computers

Although transistors were great deal of improvement over the vacuum tubes, they generated heat and damaged the sensitive areas of the computer. In third generation of computers, Integrated Circuit replaces the transistors. The Integrated Circuit(IC) was invented in 1958 by Jack Kilby. It combined electronic components onto a small silicon disc, made from quartz. More advancement made possible the fitings of even more components on a small chip or a semi conductor. Also in third generation computers, the

operating systems allowed the machines to run many different applications. These applications were monitored and coordinated by the computer's memory.

From small-scale integrated circuits (SSI) , which had about 10 transistors per chip, technology developed to medium scale integrated circuit with 100 transistors per chip. Magnetic disk technology also improved and it become feasible to have drive having capacity up to 100 MBs.

Characteristics of Third Generation Computers

- Transistors is replaced integrated circuits
- Increases speed as well as reliability.
- Uses multiprogramming operating system .
- Lower power consumption
- Magnetic disk can be used as a secondary storage.

1.5.4 Fourth Generation Computers

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 into a small chip. It reduced the size and price of the computers at the same time increasing 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 i.e. central processing unit, memory, and input and output controls on a minuscule chip."

Due to the reduction of cost and the availability of the computers power at a small place allowed everyday user to benefit. In 1981, IBM introduced personal computers for home and office use. Computer size kept getting reduced during the years. It went down from Desktop to laptops to Palmtops. Machintosh introduced Graphic User Interface in which the users 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 Networks (LAN) and Wide Area Network (WAN), were potential benefits.

Characteristics of Fourth Generation Computers

- Very large scale and ultra large scale integrated circuits has been developed.
- Computers now becomes portable.
- Semiconductor can be used as primary storage.
- Database Management system can be used
- Distributed data processing.

1.5.5 Fifth Generation Computers

Fifth generations computers are only in the minds of advance research scientists and being tested out in the laboratories. These computers will be under Artificial Intelligence (AI), They will be able to take commands in a audio visual way and carry out instructions. These computers will perform many of the operations, which require low human intelligence.

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. Future looks bright for the computers.

1.6 Types Of Computers

The computers can be broadly classified into three types

1. Analog Computers.
2. Digital Computers.
3. Hybrid Computers.

1.6.1 Analog Computers

An analog computer is a form of computer that uses electrical or mechanical phenomena to model the problem being solved. Modeling a real physical system in a computer is called simulation. In this computations are carried out with physical quantities such as voltage, length , temperature etc. The devices that measure such quantities are voltmeter and ammeter.

Computations are often performed, in analog computers, by using properties of electrical resistance, voltages and so on. For example, a simple two variable adder can be created by two current sources in parallel. The first value is set by adjusting the first current source (to say *x* milliamperes), and the second value is set by adjusting the second current source (say *y* milliamperes). The use of electrical properties in analog computers means that calculations are normally performed in real time. The core mathematical operations used in an electric analog computer are:

- summation
- inversion
- exponentiation
- logarithm
- integration with respect to time
- differentiation with respect to time
- multiplication and division

Analog computers are limited by real, non-ideal effects. An analog signal is composed of four basic components: DC and AC magnitudes, frequency, and phase. The real limits of range on these characteristics limit analog computers.

1.6.2 Digital Computers

Computers which are used today is digital computers. They work on binary digits, incase of some alphabetic information, the information must be coded in the form of by binary digit. Digital computers can be classified into two types:

1. **Purpose wise:** Purpose wise digital computers can be classified into two categories.First is, special purpose computer which is designed to perform some specific task.Second is, General purpose computer, whichis used to develop for work on different types of program.
2. **Size And Performance wise:** These digital computers can be classified as follow:

    - **Personal Computer :** A small, single-user computer based on a microprocessor. In addition to the microprocessor, a personal computer has a keyboard for entering data, a monitor for displaying information, and a storage device for saving data. The most common personal computers are desktop machines. The machines made by IBM are called IBM PCs. Other manufacturers use IBM's specification and design their own PC are known as IBM compatible PC.
    - **Workstation :** A powerful, single-user computer. A workstation is like a personal computer, but it has a more powerful microprocessor and a higher-quality monitor. They are single user computers having a lot of features of personal computer. Their processing speed is like mini computers. This powerful machine is greatly used by the scientist, engineers and other professionals. They are very expensive.
    - **Mini Computer :** These are medium sized computers. They possess more work efficiency in comparison with micro computers. Mini computers are more expensive than a micro computers and one cannot think of purchasing a mini computer for personal use. These computers are generally useful for small & medium sized company. More than one person can use this computer at a time. Mini computer possess multiple CPUs. They have bigger memory and higher speed than micro computer but less than that of main frame. They are cheaper than mainframe. A multi-user computer capable of supporting from 10 to hundreds of users simultaneously. Medium sized company can be used for following purpose:

        1. Employees Payroll
        2. Maintenance of books of accounts.
        3. Cost Analysis.
        4. Sales Supervision.

- **Mainframe :** A powerful multi-user computer capable of supporting many hundreds or thousands of users simultaneously. These are large computer with bigger storage capacity. These can store huge data bases and can also process the data wit more speed. Due to there speed in processing huge data bases, they are being used by big companies, banks etc as a centralized computer system. It can continuously work round the clock and hundreds of users can work on them simultaneously. Mainframe can easily attached to any network and even to microcomputer. These computers are used for following purpose.

To maintain customer details

1. To maintain payment details
2. To process bills
3. To process notices.

- **Super Computer :** An extremely fast computer that can perform hundreds of millions of instructions per second. These computers with biggest capacity and higher working speed among all the catgories of computers. It has multiple CPU arranged and working parallel to each other. In a super computer, a CPU consist of many ALU and each ALU is assigned for specific process, working parallel. These computers are used in the following fields:

1. In modeling nuclear fission
2. In weather forecasting
3. In space research and space exploration.

- Laptop: A **laptop computer** or simply **laptop** is a small mobile personal computer, which usually weights 4-12 pounds (2-6 kilograms), depending on size, materials and other factors.

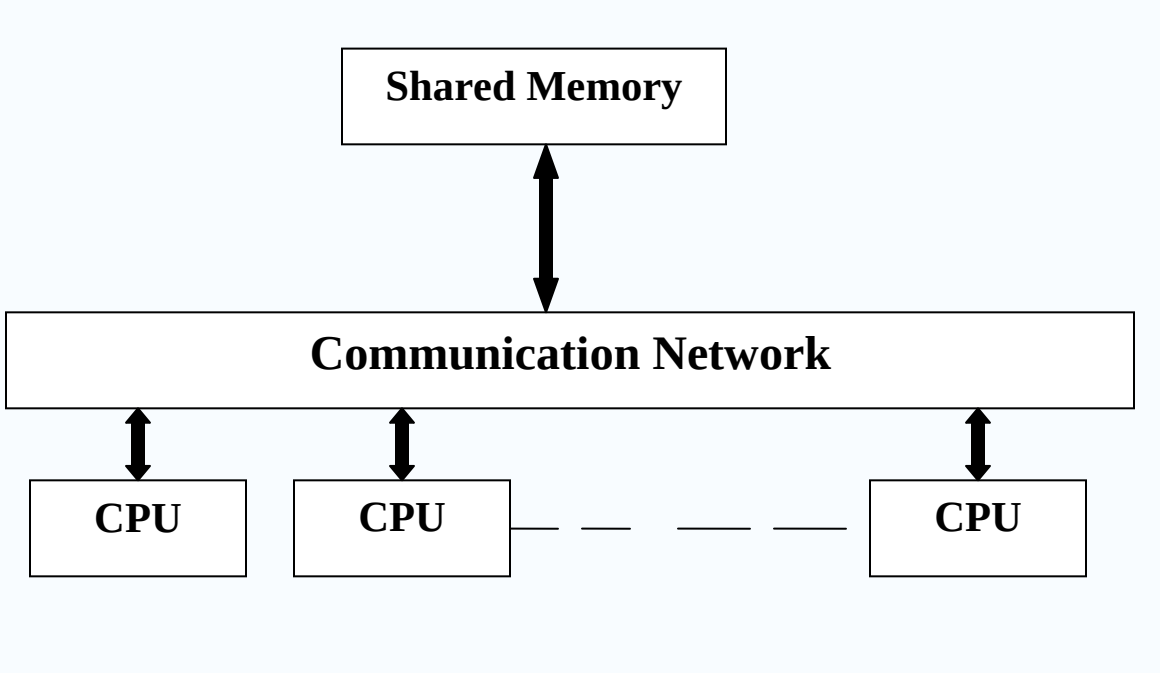
Laptops usually run on a single battery or from an external AC/DC adapter which can charge the battery while also supplying power to the computer itself.

Distributed Computer System: A configuration in which several computers are interconnected by a communication network is called distributed computer system. A common use of distributed computer system is called client server computing. The PC which is requesting for the srevices is called client and the computer providing the services is called server.

Sometime there are problems requirng either large storage or high speed processing which cannot be solved using a single computer in a network. In such cases it may be possible to get a set of computers

connected to the network to cooperate and solve the problem. In distributed computer system it often happens that many computers are not fully utilized. In such cases a user requiring more CPU resources than what he as in his computer can steal CPU cycles from idle processor to do his job. The communication network connecting te computers in a distributed system is normally slow and allows only one message to be communicated between two computers at a time. This type of network is called LAN(Local Area Network).

Parallel Computers: A set of computers connected together by a high speed communication network and programmed in sucha way that they can cooperate to solve a single large problem is called a parallel computer. There are two major types of parallel computers. One of them is called a **shared parallel computer**. In this case a number of processing elements are connected to a common main memory by a communication network. A program for this computer is written in such a way that multiple processsor can work independently and cooperate to solve problem. The processes are allocated to different processors and they read and modify the data accessible to all of them in memory.

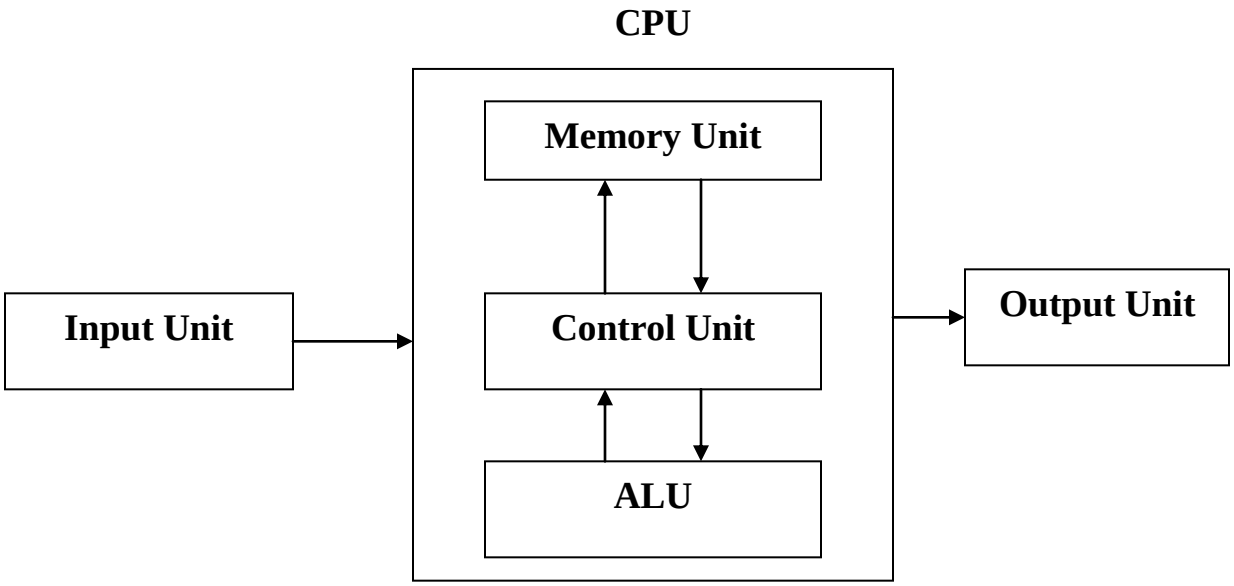


The other type of parallel computer is called a **distributed memory computer**. In this type a number of processors, each with its own memory are interconnected by a communication network. A program is divided into many parts and each computer work independently. Whenever processo need to exchange data to continue with computation they do so by sending messages across the network.Such computers are called message passing multicomputers. A popular interconnection network is called a hypercube.

1.6.3 Hybrid Computers

Hybrid computers are made by combining features of analog computers and digital computers. In general, analog computers are extraordinarily fast, since they can solve most complex equations at the rate at which a signal traverses the circuit, which is generally an appreciable fraction of the speed of light. Digital computers can be built to take the solution of equations to almost unlimited precision, but quite slowly compared to analog computers. Hybrid computers can be used to obtain a very good but relatively imprecise 'seed' value, using an analog computer front-end, which is then fed into a digital computer iterative process to achieve the final desired degree of precision. Hybrid computers utilizes the best qualities of digital and analog computer.

1.7 Block diagram of Computers looks like the one below



A. Central Processing Unit

A central processing unit (CPU), or sometimes simply called processor**,** is the component in a digital computer that interprets instructions and processes data contained in computer programs. CPUs provide the fundamental digital computer trait of programmability, and are one of the necessary components found in computers of any era, along with primary storage and input/output facilities. A CPU that is manufactured using integrated circuits is known as a microprocessor. A typical central processor unit (CPU) consists of the following interconnected functional units:

- Registers
- Arithmetic/Logic Unit (ALU)
- Control Unit

B. Registers:

Register consist of flip flops. These flip flops are connected in parallel. A CPU contains a number of registers to store data temporarily during the execution of a program. The no of register is differ from processor to processor. The advantages of storing the data in register are that it can be retrieved faster than memory because the number of register in the memory is very less. The drawback of using the register is that it is very expensive. Register are classified as follows:

1. **Accumulator:** It is a register, which holds one of the operand prior to the execution of instruction and receives the result of most of the arithmetic and logic operations. It is one of the frequently used registers.
2. **General Purpose Register:** These register stores data and intermediate result during the execution of a program. These are accessible to the user if the user is working in assembly language.
3. **Special Purpose Register:** A CPU contains a number of special purpose registers. It is used for different purpose. These are:
    - Program counter
    - Stack pointer
    - Status register
    - Instruction register
    - Memory address register
    - Memory buffer register

    Program Counter: It holds the address of the memory location, which contains the next instruction, which is to be fetched from the memory. It content is automatically incremented after the execution of an instruction.

    Stack Pointer: It is used to save the contents of the register if it is required during the execution of a program.

    Status Register: It is a 1-bit flag, which is used to indicate certain condition that arises during the arithmetic and logic operation.

    Instruction Register: It holds the instruction until it is decoded.

    Memory Address Register: It holds the address of the instruction or data to be fetched from the memory.

    Memory Buffer Register: It holds the instruction code or data received from or sent to the memory. The data which are written into the memory are held in this register until write operation is completed.

- **Arithmetic/Logic Unit:** All processors contain an arithmetic/logic unit, which is often referred to simply as the ALU. The ALU, as its name implies, is that portion of the CPU hardware which performs the arithmetic and logical operations on the binary data .The ALU must contain an Adder which is capable of combining the contents of two registers in accordance with the logic of binary arithmetic. This provision permits the processor to perform arithmetic manipulations on the data it obtains from memory and from its other inputs. The ALU contains Flag Bits, which specify certain conditions that arise in the course of arithmetic and logical manipulations. Flags typically include Carry, Zero, Sign, and Parity.

- **Control Unit:** The control unit is the primary functional unit within a CPU. Using clock inputs, the control circuitry maintains the proper sequence of events required for any processing task. After an instruction is fetched and decoded, the control circuitry issues the appropriate signals for initiating the proper processing action. Often the control circuitry will be capable of responding to external signals, such as an interrupt or wait request An Interrupt request will cause the control circuitry to temporarily interrupt main program execution.

1.8 Problem Solving Using Computers

To solve a problem using a computer following steps are carried out.

1. The given problem is analyzed.
2. The method used to solve the problem is broken down into a sequence of elementary tasks.
3. Based on the analysis an algorithm to solve the problem is formulated. The algorithm should be precise, concise & unambiguous (not repeated).
4. The algorithm is expressed in a precise notation. An algorithm expressed using a precise notation is called a computer program.
5. The computer program is fed to the computer.
6. The computer's processing unit interprets the instructions in the program, executes them and sends the result to the output unit.

1.9 Computer Hardware:

The data are processed by a collection of electronic circuits and other devices that make up the computer system. The physical component that you can see, touch and feel in the computer system is called hardware. **Computer hardware** is the physical part of a computer, including the digital circuitry, as distinguished from the computer software that executes within the hardware. The hardware of a computer is infrequently changed, in comparison with software and data, which are "soft" in the sense that they are readily created, modified or erased on the computer. Most computer hardware is not seen by normal users. It is in embedded systems in automobiles, microwave ovens, electrocardiograph machines, compact disc players, and other devices.

The term **hardware** covers all of those parts of a computer that are tangible objects. Circuits, displays, power supplies, cables, keyboards, printers and mice are all hardware. These Components are:

- CPU: CPU stands for Central processing unit. It is the brain of the computer. The part of the computer that performs the bulk of data processing operations is called central processing unit. The CPU fetches the instruction of the program from the memory at time, decodes it and then executes it. CPU takes the data from the input unit , process it and passes the output to the output unit. The CPU consist of the following units:
    - Memory Unit
    - Control Unit
    - ALU

✓ Memory Unit: Memory is one of the most wonderful features on computer. It is one of the most important parts of this system. In this unit the data and result are stored. This unit consists of cells. Each cell has a numbered "address" and can store a single number. The function of the memory is to store information, it stores data result, or any other kind of information. There are two types of memory:

➢ Primary Memory: It is also called primary storage devices and it is directly connected to the CPU. . It stores program along with the data which is to be exected. It is a volatile memory.

➢ Secondary Memory: It is an additional part of storing the data which is not directly attached to the computer system. . It has much larger capacity than main memory. Secondary memory is also known as auxiliary memory. The magnetic memory is used as secondary memory. It is a non volatile memory.

✓ Control Unit: This is that unit of the CPU, which coordinates all the activities of each and every element of computer. It control the entire operation of the computer system. It fteches the instruction from the memory decodes the instruction, interprets the instruction to know what task are to be performedand sends suitable control signal to other component to perform necessary step to execute the instruction. It gives order to ALU what operation is to be performed . It generates timing and control signal and provide them for all operation. It control the data flow between CPU and peripherals.

✓ ALU: ALU stand for arithmetic and logic unit. It is used to perform certain arithmetic and logical operation like Addition, Multiplication, Logical And , Logical Or etc. If, an addition operation was requested, an arithmetic logic unit (ALU) will be connected to a set of inputs and a set of outputs. The inputs provide the numbers to be added, and the outputs will contain the final sum.

1.10 Computer Software

The term "software" was first used in this sense by John W. Tukey in 1957. In computer science,computer software is nothing but all computer programs.To perform any task on computer, the programmer has to write a set of instruction. This sequence of instruction given to the computer is called a program. A set of program written for the computer is called software. Software is a program that enables a computer to perform a specific task, as opposed to the physical components of the system. This includes application software such as a word processor, which enables a user to perform a task, and system software such as an operating system, which enables other software to run properly, by interfacing with hardware and with other software. In computers, software is loaded into RAM and executed in the central processing unit. At the lowest level, software consists of a machine language specific to an individual processor. A machine language consists of groups of binary values signifying processor instructions i.e. object code. Software is an ordered sequence of instructions for changing the state of the computer hardware in a particular sequence. It is usually written in high-level programming languages that are easier and more efficient for humans to use than machine language. High-level languages are compiled or interpreted into machine language object code. Software may also be written in an assembly language, essentially, a mnemonic representation of a machine language using a natural language alphabet. Assembly language must be assembled into object code by the help of assembler. Software is categorized on the basis of application it performs. Software can be classified on the basis of three categories.

System Software
Application Software
Utility Software

1.10.1 System Software

As you know that, a set of programs written for the computer is called software. The software required to execute user program is called system software. This software controls all processing activities and make sure that resources and the power of the computer are used in most efficient manner. The major purpose of system software is it controls the execution of program and helps in the development of software.

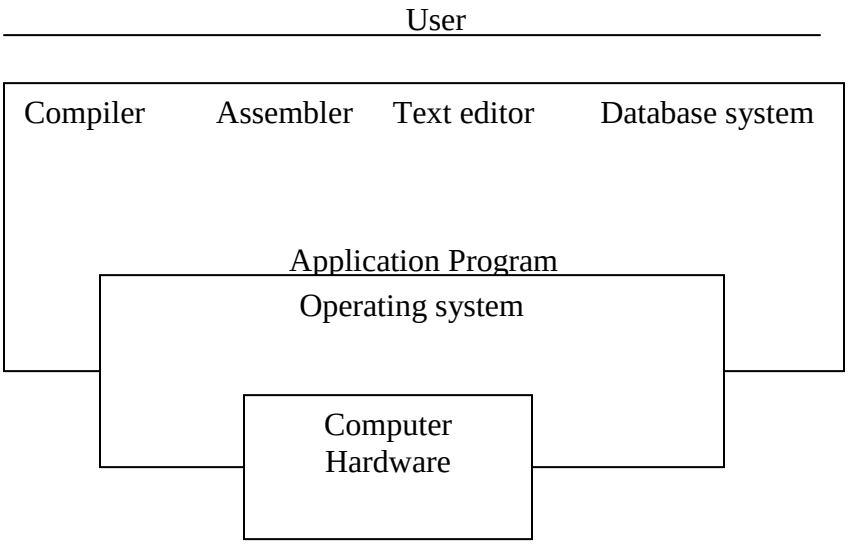
System software helps in running the computer hardware and computer system. It includes operating systems, device drivers, diagnostic tools, servers, windowing systems, utilities and more. The purpose of systems software is to insulate the applications programmer as much as possible from the details of the particular computer complex being used, especially memory and other hardware features, and such accessory devices as communications, printers, readers, displays, keyboards, etc. System software can be classfied into two categories.

- Operating System
- Language Processor

A. Operating system

An operating system is a program that acts as an intermediate between the user and computer hardware. It is a computer program that manages the hardware and software resources of a computer. At the foundation of all system software, the OS performs basic tasks such as controlling and allocating memory, prioritizing system requests, controlling input and output devices, facilitating networking, and managing files. It also may provide a graphical user interface for higher level functions. The purpose of an operating system is to provide an environment. In which user can execute the program.

Modern general-purpose computers, including personal computers and mainframes, have an operating system to run other programs, such as application software. Examples of operating systems for personal computers include Microsoft Windows, and Linux. The primary goal of an operating system is thus to make the computer system convenient to use. A secondary goal is to use the computer hardware in an efficient manner.



When the hardware provides the basic computing resources, then the application program defines the way in which these resources are used to solve certain problem. Operating system controls and coordinates the use of hardware among the application program. Efficiency of operating system can be measured on the basis of following 3 factors.

1. Turn around time : It is the time delay between the submission and completion of any job.
2. Response time: It is the time taken by the system to give first response.
3. Throughput: It is the no of job executed in an unit time.

Computer Software:

B. Language Processor

When a program written in a language other than the machine language of computer, the computer will not understand it. Hence, the program written in other language must be translated into the machine language of the computer. Such translation is done with the aid of software. This type of software is known as language processor.

A Compiler

A compiler is a computer program or set of programs that translates text written in a computer language i.e. in the source language into another computer language i.e. the target language. The original sequence is usually called the source code and the output called object code. The most common reason for wanting to translate source code is to create an executable code. The name "compiler" is primarily used for programs that translate source code from a high level language to a lower level language or machine language. A program that translates from a low level language to a higher level one is a decompiler. A compiler is likely to perform many or all of the following operations: lexing, preprocessing, parsing.

Early computers did not use compilers. Compilers had not yet been invented because early computers had very little memory and programs were necessarily quite short. Users often entered the decimal or binary machine code for a program. With the evolution of programming languages and the increasing power of computers, compilers are becoming more and more complex to bridge the gap between problem-solving modern programming languages and the various computer.

A compiler is itself a computer written in some implementation language. Early compilers were written in assembly language. The first self-hosting compiler which is capable of compiling its own source code in a high-level language — was created for Lisp.

- A program that translates from a low level language to a higher level one is a decompiler.
- A program that translates between high-level languages is usually called a language translator.

Most compilers are classified as either self-compilers or cross compilers. If a compiler run on a computer for which it produces the object code, then it is known as self-compiler. If a compiler run on a computer other than that for which it produces the object code, then it is known as cross compiler.

B Assembler

A program that converts an assembly language program into machine language so that computer can run the program. As you know that assembly language program can be written by making use of mnemonic code (symbolic code). The use of symbolic references is a key feature of assemblers, saving tedious calculations and manual address updates after program modifications. Assemblers are available since the 1950s. An assembler, which runs on the computer for which it produces the object code, is called self-assembler. The assembler runs on the computer other than that for which it produces the object code is called cross assembler. There is two types of assembler, first is one pass assembler, it is an assembler which read the program once and assign addresses to the labels used in assembly language program. Second is Two pass assembler, which goes to the program twice, in first pass it will assign address to the labels and in the second pass it will convert each assembly language instruction into machine language instruction.

More sophisticated High-level assemblers provide language abstractions such as:

- Advanced control structures.
- High-level procedure/function declarations and invocations.
- High-level abstract data types, including structures/records, unions, classes, and sets.
- Sophisticated macro processing.

C Interpreter

An interpreter is a program which translates a high level language rogram into machine level language. It translates one instruction of a program at a time. If it is correct then only it proceeds towards the next instruction. It reads the instruction, translate it,and after that it executes the instruction. An interpreter is a smaller program as compared to the compiler. It occupy less memory space. Interpreting code is slower than running the compiled code because the interpreter must analyse each statement in the program each time it is executed and then perform the desired action whereas the compiled code just performs the action. Access to variables is also slower in an interpreter because the mapping of identifiers to storage locations must be done repeatedly at run-time rather than at compile time. The IBM 550 Numeric Interpreter and IBM 557 Alphabetic Interpreter are typical examples of the interpreter.

1.10.2 Application Software

Application software allows humans to accomplish one or more specific tasks.It is a set of program that is necessary to carry out operation for a specified application. Typical applications include industrial automation, business software, educational software, medical software, databases. Almost every field of human activity now uses some form of application software. It is used to automate all sorts of functions.

Application software or Applications are what most people think of when they think of software. Application software is often purchased separately from computer hardware.

Sometimes applications are bundled with the computer, but that does not change the fact that they run as independent applications. Applications are almost always independent programs from the operating system

Customized Application software: The software which is developed to meet all the requirement specified by the user.

General Application software: The software which is developed by keeping all the general requirements in mind for carrying out a specific task.These are those software which are developed by the group of people or an individual to be use by the other.For e.g. word processing software, Electronic spread sheet etc.

1.10.2.1 Application software consist of Packages and Business software.

A Packages

Software package, in computing, a type of file format where software installation material is grouped together. A software package is a bundle of one or several files that either are necessary for the execution of a computer program, or add features for a program already installed on the computer or network of computers. Software packages can either be in a standardised package format to be installed by a program that is integrated with the operating system, or be a self-sufficient installer.

The term software package is also used in object-oriented programming to name a group of related classes of a program. In this, meaning of packages are especially useful to measure and control the inherent coupling of a program. Some most common packages that are mostly used are:

- Word Processor
- Electronic Spreadsheet
- Database Management System
- Desktop publishing

Word Processor

It is an application program designed to replace a typewriter. A word processor manages text-based documents. It allows the user to enter, edit, view, store and retrieve the text material. These text material may be letter, reports, or book etc. It is very easy to make corrections in the data which is written there. Editing in the documents like to insert or delete a word or sentences from the document can be done very easily.

In word processing, there is automatic flowing of text on to the next line as new text is inserted. It means, when an operator enters the character to the document and as soon they reached at the end of the line the word processor program automatically moves the

text to the next line. This feature of the word processing is known as word wrap. Word wrap ensures that the text stays inside the designated document boundaries or margins. Word processing program also provides us certain features like boldface, italic, superscript, sub script etc. It also provide certain alignment like left, right, center.

Word processor vary from simple to the complex. An advanced word processor must contain all the features needed for entering, editing and formatting the text as well as support macros to simplify complex or routine task. It also include facility for spell checking (speling check), dictionary etc.WordPerfect from Word Perfect Corporation and Microsoft word are examples of fully featured word processor.

Electronic Spreadsheet

A spreadsheet is a rectangular table (or grid) of information, which is often used for giving financial information. The word came from "spread" in its sense of a newspaper or magazine item (text and/or graphics) that covers two facing pages, extending across the center fold and treating the two pages as one large one. The compound word "spread-sheet" came to mean the format used to present bookkeeping, ledgers.

One of the first commercial uses of computers was in processing payroll and other financial records, so the programs were designed to generate reports in the standard "spreadsheet" format, bookkeepers and accountants used it. The generally recognized inventor of the spreadsheet as a commercial product for the personal computer is Dan Bricklin. The spreadsheet or work sheet consists of rows and columns of cells. The rows are usually identified by numbers, and columns by letters. Each cell can hold a numeric value, text label or a formula that produces values contained in other cells.

Many people find it easier to perform calculations in spreadsheets than by writing the equivalent sequential program. This is due to two traits of spreadsheets.

- They use spatial relationships to define program relationships. Like all animals, humans have highly developed intuitions about spaces, and of dependencies between items.
- They are forgiving, allowing partial results and functions to work. One or more parts of a program can work correctly, even if other parts are unfinished or broken. This makes writing and debugging programs much easier, and faster. Sequential programming usually needs every line and character to be correct for a program to run. One error usually stops the whole program.

In a spreadsheet, however, a set of cells is defined, with a spatial relation to one another. In the earliest spreadsheets, these arrangements were a simple two-dimensional grid. Over time, the model has been expanded to include a third dimension also which is known as 3-D spreadsheet. Lotus 1-2-3 from Lotus Development Corp, Quattro Pro developed by Borland International and Microsoft Excel are examples of spreadsheet programs. Some of the problems associated with spreadsheets are:

- Lack of auditing. This makes it difficult to determine who changed what and when.
- Lack of security. Generally, if one has permission to open a spreadsheet, one has permission to modify any part of it. This, combined with the lack of auditing above, can make easy for someone to commit fraud.
- Lack of concurrency. Unlike databases, spreadsheets typically allow only one user to be making changes at any given time.

Database Management System

It is an application software that controls the data in the database, including overall organization, storage, security, data integrity.A database management system (DBMS) is a system or software designed to manage a database, and run operations on the data requested by numerous clients. Typical examples of DBMS use include accounting, human resources and customer support systems. A DBMS is a complex set of software programs that controls the organization, storage and retrieval of data in a database. The DBMS accepts requests for data from the application program and instructs the operating system to transfer the appropriate data.

When a DBMS is used, information systems can be changed much more easily as the organization's information requirements change. New categories of data can be added to the database without disruption to the existing system. Database servers are specially designed computers that hold the actual databases and run only the DBMS and related software.

Features Of DBMS

- **Persistence** - Attributes are permanently stored on a hard-drive or other fast, reliable medium until explicitly removed or changed.
- **Concurrency** - Many people may want to change and read the same attributes at the same time. For example, if you change the color attribute of car 7 to be "blue" at the very same time somebody is changing it to "red", then you may not see your change when you go to view the attributes of the car you thought you just changed. DBMS provide various tools and techniques to deal with such issues. "Transactions" and "locking" are two common techniques for concurrency management.
- **Security** - Often it is desirable to limit who can see or change which attributes or groups of attributes.
- **Computation** - There are common computations requested on attributes such as counting, summing, averaging, sorting, grouping, cross-referencing, etc can be done.
- **Meta-data Repository** - Meta-data is information about information. For example, a listing that describes what attributes are allowed to be in data sets is called "meta-information".

A DBMS can also format reports for printed output , and import and export data from other application programs by making use of standard file format. A data manipulation language is also provided to support queries against the database.

Desktop publishing Software

The use of computer with specialized page layout software to combine text and graphics into a single document that can be printed on a aser printer. The original document text is usually wrtten by using a word processor and the line art are prepared with a paint program, photographs can be incorporated as scanned images. All of these separate elements are then brought together in the page layout or desktop publishing program, where they can usually be imported directly as separate files. The software that handles page layout by combining the functions of a traditional typesetter and a layout artist is known as desktop publishing software.Hardware for desktop publishing may include a high speed personal computer with a large capacity hard dik and a full-pabe display, a scanner and a laser printer.

B Business Software

Business software is generally any software program that helps a business increase productivity or measure their productivity. The term covers a large variation of uses within the business environment, and can be categorized by using a small, medium and large matrix.The software that is developed by keeping all the requirement of business in mind is known as business software. There are many types of business softwrae are available in market like inventory management system, payroll system, Hotel management system. Some of them are explained below:

Inventory Management System

An inventory management system is an integrated package of software and hardware used in warehouse operations, and elsewhere, to monitor the quantity, location and status of inventory as well as the information related to the shipping, receiving, picking and putaway processes. Modern inventory control systems rely upon barcodes to provide automatic identification of inventory objects. An inventory control system may be used to automate a sales order fulfillment process. Such a system contains a list of order to be filled, and then prompts workers to pick the necessary items, and provides them with packaging and shipping information. Real time inventory control systems use wireless, mobile terminals to record inventory transactions at the moment they occur. Some Widely used inventory control systems are:

- Inventory Control Software - Soft-Aid
- IntelliTrack
- ACCPAC, published by The Sage Group
- HighJump Software, a division of 3M
- S3CO
- Inventory Control Software – AMICS

Payroll System

In a company, payroll is the sum of all financial records of salaries, wages, bonuses, and deductions. A paycheck is traditionally a paper document issued by an employer to pay an employee for services rendered. A payroll savings program is a method of automatically deducting money from one's paycheck and depositing it into a savings account. Since these funds are made less available there is a reduced chance that they will be spent. A payroll card is a card that allows an employee to access their paycheck by using a card that looks like a bank debit card. A payroll card can be more convenient than using a check casher, because it can be used at participating automatic teller machines to withdraw cash. Some payroll cards also are cheaper than Payday loans available from retail check cashing stores. The payroll card account usually is held as a single account in the employer's name. That account holds the payroll funds for all employees using the payroll card system. Some payroll card programs establish a separate account for each employee, but others do not.

Financial Accounting

Financial Accounting software is computer software that records and processes accounting transactions within functional modules such as accounts payable, accounts receivable, payroll and trial balance. It functions as an accounting information system. It may be developed in-house by the company or organization using it, may be purchased from a third party, or may be a combination of a third-party application software package with local modifications. It varies greatly in its complexity and cost.

Accounting software is typically composed of various modules. Among the most common are:

- Accounts receivable—where the company enters money received.
- Accounts payable—where the company enters its bills and pays money it owes.
- General ledger—the company's "books".
- Billing—where the company produces invoices to clients/customers.
- Stock/Inventory—where the company keeps control of its inventory.
- Purchase Orders—where the company orders inventory.
- Sales Orders—where the company records customer order for the supply of inventory.

The most complex and expensive business accounting software is frequently part of an extensive suite of software often known as Enterprise resource planning or ERP software.

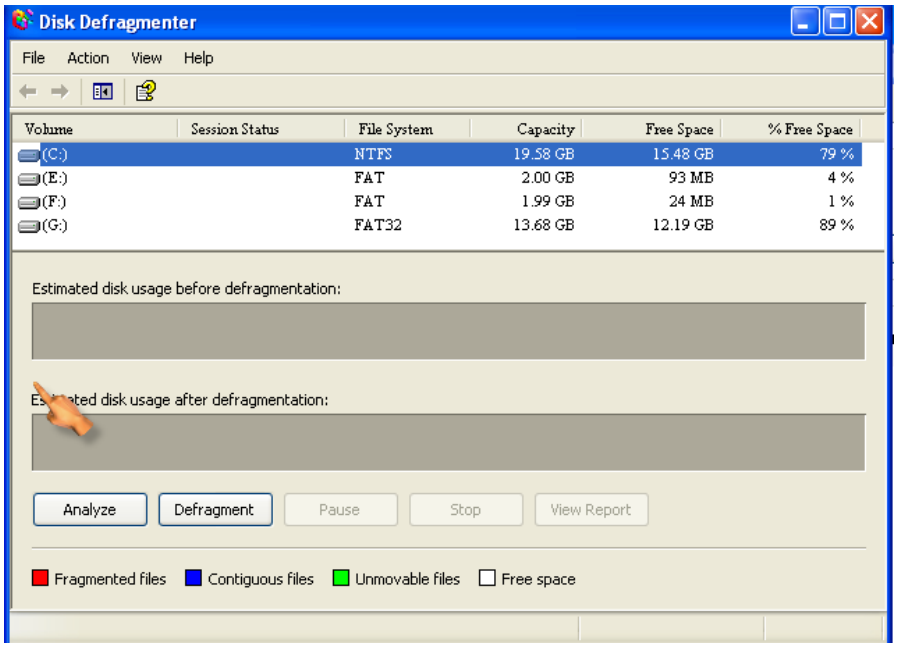
These applications typically have a very long implementation period, often greater than six months. In many cases, these applications are simply a set of functions which require significant integration, configuration and customisation to even being to resemble an accounting system.

1.10.3 Utility Software

It is a set of program, that supports the operating system by providing the additional services that the operating system does not provide. There are many task which are performed by utility programs are hard disk backup, disk optimization, file recovery, safe formatting and resource editing.

Utility software is also known as service program, or utility routine. It is specifically designed to help in managing and tune the computer hardware, operating system or application software, and perform a single task or a small range of tasks.Some important utilities are bein discussed below:

- **Disk defragmenters/Disk management tools** Disk defragmenter can detect computer files whose contents have been stored on the hard disk in disjointed fragments, and move the fragments together to increase efficiency. There is a Disk checker which can scan the contents of a hard disk to find files or areas that are corrupted in some way, or were not correctly saved, and eliminate them for a more efficiently operating hard drive. A Disk cleaner can find files that unnecessary to computer operation, or take up considerable amounts of space. Disk cleaner helps the user to decide what to delete when his hard disk is full. To start disk defragmentation we have to click start>Programs>Accessories>System tools>Disk Defragmentation. It will show like this



- **Virus scanners/Antivirus**. Virus Scanners scan for computer viruses among files and folders. Virus is a program intended to damage your computer sytem without your knowledge and belief. A virus may itself attach to another programon your hard disk and when the date passes, or a certain event occurs, the virus is trigerred into action. The most famous virusis jerusalem virus, which is also known as

Friday the 13th, first seenat the university of jerusalem in july 1987. The virus slow down the system. There are several precautions that you can take to protect yoursef from infection, including backing up your system on the regular basis , and you can also buy and run the commercially available virus detecting program.

Antivirus is an application program that can detect and eliminate the computer virus. Some antivirus program can detect suspicious activity on your computer as it happens. While, the other must be run periodically. The antivirus program locates and identifies a virusby looking some of the characteristics, like unexpected disk access. It recognizes the virusby comparing the information from the system against the database of known virus that is kept n the disk. There are several simple precautions that you can take to minimize your chances of contracting a virus:

1. Back up your hard disk regularly.
2. Do not install software if you don't know where it's been or where it came from.
3. Write protect disks as soon as you get them.

- **Compression** utilities output a shorter stream or a smaller file when provided with a stream or file. A file that has been processed by a special utility programso that it occupies a little hard disk space. When the file is needed, the same program decompresses the file back into its original form so that it can be read by the computer. Two kind of file file compression program are available those program that cancompress more than one file at a time such as winzip. Those program that can compress al the files on a specific disk.Any method of encding data so that it occupies less space than its original form.

- **File Management tools** A file manager or file browser is a computer program that provides a user interface to work with file systems. They are very useful for speeding up interaction with files. The most common operations on files are create, open, edit, view, print, play, rename, move, copy, delete, attributes, properties, search/find, and permissions.
- **Encryption** utilities use a specific algorithm to produce an encrypted stream or encrypted file when provided with a key and a plaintext.

1.11 Central Processing Unit

CPU is an acronym for central processing unit. It is a brain of the computer. The primary function is to execute the program. The program, which is to be executed, is stored in the main memory. The CPU fetches one instruction from the memory at a time, decodes it and after decoding the instruction it under stands what operation is to be performed. After knowing the operations, it will execute the instruction as specified. After decoding it also came to know that the data, which is used in the program, is stored either in the main memory or in register. If the data is stored in the memory, then CPU reads the data from memory. Then it executes the instruction. After executing one instruction it fetches the next instruction for execution. This process is continued unless and until all the

instruction of a program is fetched and executed. Besides executing the program, the CPU also control input devices, output devices and other components of computer.

After the fetch and decode steps, the execute step is performed. During this step, various portions of the CPU are connected so they can perform the desired operation. If, for instance, an addition operation was requested, an arithmetic logic unit (ALU) will be connected to a set of inputs and a set of outputs. The final step, writeback, simply "writes back" the results of the execute step to some form of memory. Very often the results are written to some internal CPU register for quick access by subsequent instructions. In other cases results may be written to slower, but cheaper and larger, main memory. Some types of instructions manipulate the program counter rather than directly produce result data. There are many steps which may be performed concurrently or in a different order by the CPU depending on its type:

1. Read the code for the next instruction from the cell indicated by the program counter.
2. Decode the numerical code for the instruction into a set of commands or signals for each of the other systems.
3. Increment the program counter so it points to the next instruction.
4. Read whatever data the instruction requires from cells in memory (or perhaps from an input device). The location of this required data is typically stored within the instruction code.
5. Provide the necessary data to an ALU or register.
6. If the instruction requires an ALU or specialized hardware to complete, instruct the hardware to perform the requested operation.
7. Write the result from the ALU back to a memory location or to a register or perhaps an output device.
8. Jump back to step (1).

1.11.1 CPU consist of

- ALU (Arithmetic Logic Unit)
- Control Unit
- General And Special Purpose Register

A. ALU (Arithmetic Logic Unit)

The abbreviation stands for Arithmetic Logic Unit. The function of this unit is to perform arithmetic and logical operations like Addition, Subtraction, Multiplication, Division, Logical AND, Complement etc. If, an addition operation was requested, an arithmetic

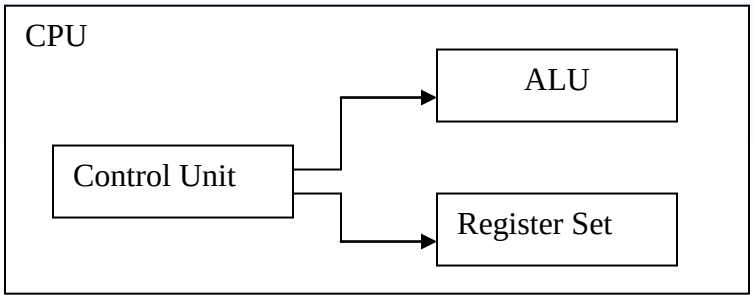
logic unit (ALU) will be connected to a set of inputs and a set of outputs. The inputs provide the numbers to be added, and the outputs will contain the final sum. The ALU contains the circuitry to perform simple arithmetic and logical operations on the inputs .If the addition operation produces a result too large for the CPU to handle, an arithmetic overflow flag in a flags register may also be set.

Other mathematical operationsuch as exponentia, logarithmic and floating point operation are performed by special purpose math processor called floating point unit.

B. Control Unit

A control unit is the part of a CPU device that directs its operation. The outputs of the unit control the activity of the rest of the device. A control unit can be thought of as a finite state machine. It control the entire operation of the computer system. It fteches the instruction from the memory decodes the instruction, interprets the instruction to know what task are to be performedand sends suitable control signal to other component to perform necessary step to execute the instruction. It gives order to ALU what operation is to be performed . It generates timing and control signal and provide them for all operation. It control the data flow between CPU and peripherals. It performs the following functions

1. It can get the instruction out of the memory unit.
2. It can decode the instruction.
3. It sets up the routing through internal wiring.
4. It can determine the storage from where it is to get the next instruction.



Control units are usually one of these types:

1. Microcoded control units. In a microcoded control unit, a program reads signals, and generates control signals. The program itself is executed by a very simple computer, a relatively simple digital circuit called a microsequencer.
2. Hardware control units. In a hardware control unit, a digital circuit generates the control signals directly.

The control system's function is as follows

- The address of the memory location where the instruction lies, is placed on the address bus.
- Instruction is read from memory.
- The instruction is sent to the decoding circuitry for decoding.
- Address and data required for the execution is read from the memory.
- These data and addresses are sent to the other section for processing.
- The result is sent to the memory or in some register.
- Necessary steps are taken to fetch the instruction. For this content of the program counter is get incremented.

C. Registers

Register consist of flip flops. These flip flops are connected in parallel. A CPU contains a number of registers to store data temporarily during the execution of a program. The no of register is differ from processor to processor. The advantages of storing the data in register are that it can be retrieved faster than memory because the number of register in the memory is very less. The drawback of using the register is that it is very expensive. Register are classified as follows:

4. **Accumulator:** It is a register, which holds one of the operand prior to the execution of instruction and receives the result of most of the arithmetic and logic operations. It is one of the frequently used registers.
5. **General Purpose Register:** These register stores data and intermediate result during the execution of a program. These are accessible to the user if the user is working in assembly language.
6. **Special Purpose Register:** A CPU contains a number of special purpose registers. It is used for different purpose. These are:
    - Program counter
    - Stack pointer
    - Status register
    - Instruction register
    - Memory address register
    - Memory buffer register

Program Counter: It holds the address of the memory location, which contains the next instruction, which is to be fetched from the memory. It content is automatically incremented after the execution of an instruction.

Stack Pointer: It is used to save the contents of the register if it is required during the execution of a program.

Status Register: It is a 1-bit flag, which is used to indicate certain condition that arises during the arithmetic and logic operation.

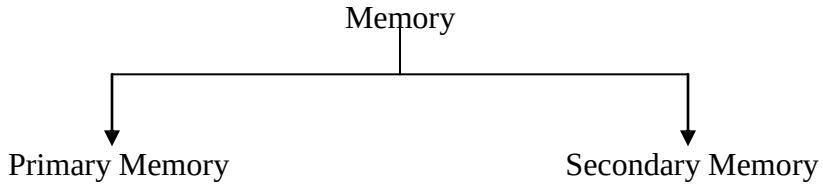
Instruction Register: It holds the instruction until it is decoded.

Memory Address Register: It holds the address of the instruction or data to be fetched from the memory.

Memory Buffer Register: It holds the instruction code or data received from or sent to the memory. The data which are written into the memory are held in this register until write operation is completed.

1.12 Memory

Computer storage, computer memory, and often casually memory refer to computer components, devices and recording media that retain data for some interval of time. It is one of the fundamental components of all modern computers, and coupled with a central processing unit (CPU). A computer's memory may be viewed as a list of cells into which numbers may be placed or read. Each cell has a numbered "address" and can store a single number. The function of the memory is to store information, it stores data result, or any other kind of information. Data that are being processed are held in primary memory which is capable of sending and receiving the data at a very high speed. Secondary memory stores data not currently being used and operate morwe slowly but it is capable of storing large volume of data.



1.12.1 Characteristics Of Memory

- **Volatile memory**: Memory requires constant power to maintain the stored information. Volatile memory is typically used only for primary storage. When the power supply is off data present in the volatile memory disappears.
- **Non-volatile memory**: This type of memory will retain the stored information even if it is not constantly supplied with electric power. It is suitable for long-term storage of information, and therefore used for secondary, tertiary, and off-line storage.

- **Dynamic memory:** It is volatile memory which also requires that stored information is periodically refreshed, or read and rewritten without modifications.
- **Random access**: It means that any location in storage can be accessed at any moment of time. This makes random access memory well suited for primary storage.
- **Sequential access**: It means that the accessing a piece of information will take a varying amount of time, depending on which piece of information was accessed last. The device may need to seek (e.g. to position the read/write head correctly), or cycle (e.g. to wait for the correct location in a constantly revolving medium to appear below the read/write head).
- **Storage capacity:** It is the total amount of stored information that a storage device or medium can hold. It is expressed as a quantity of bits or bytes

1.12.2 Primary Memory/ Storage

Primary storage is directly connected to the central processing unit of the computer. It must be present for the CPU to function correctly, just as in a biological analogy the lungs must be present (for oxygen storage) for the heart to function (to pump and oygenate the blood). It is a faster memory. It stores program along with the data which is to be exected. It also store necessary program of a system software which are required to execute user program. It is a volatile memory. Primary storage typically consists of three kinds of storage:

- **Processor registers** are internal to the central processing unit. Registers contain information that the arithmetic and logic unit needs to carry out the current instruction. They are technically the fastest of all forms of computer storage, being switching transistors integrated on the CPU's silicon chip, and functioning as electronic "flip-flops".
- **Cache memory** is a special type of internal memory used by many central processing units to increase their performance or "throughput".It is a semiconductor memory. Some of the information in the main memory is duplicated in the cache memory, which is slightly slower but of much greater capacity than the processor registers, and faster but much smaller than main memory. In this the active portion of program and data are placed in a fast small memory , the average acess time can be reduced. The cache memory access time is less than the access time of main memory by a factor of 5 to 210. Multi-level cache memory is also commonly used - "primary cache" being smallest, fastest and closest to the processing device; "secondary cache" being larger and slower, but still faster and much smaller than main memory.

The basic operation can be done like this: When CPU needs to access the memory, the cache is examined first, if the word is found then it is read from there only. If, not then main memory is accessed to read the word. A bock of words containing that word which is just accessed is then transferred from main memory to cache memory.The block size may vary from 1 word to 16 word.

- **Main memory** contains the programs that are currently being run and the data the programs are operating on. The arithmetic and logic unit can very quickly transfer information between a processor register and locations in main storage, also known as a "memory addresses". In modern computers, electronic solid-state random access memory is used for main storage, and is directly connected to the CPU via a "memory bus"and a "data bus". The memory bus is also called an address bus or front side bus and both busses are high-speed digital "superhighways". Access methods and speed are two of the fundamental technical differences between memory and mass storage devices. It is broadly categorised in two:

    1. **RAM :** Random-access memory usually known by its acronym, RAM refers to data storage formats and equipment that allow the storing data to be accessed in any order — that is, at random, not just in sequence. Computers use RAM to hold the program code and data during computation. A defining characteristic of RAM is that all memory locations can be accessed at almost the same speed. Most other technologies have inherent delays for reading a particular bit or byte. The user can write the information into the RAM and also able to read the information from it. It posses random access property. It is a volatile memory.

    The read and write memory of a computer is called RAM. The user can write information into RAM and read information from it. It is accessible to user.The user enters his program into the RAM. It posses random access property. In a random access memory any memory location can be accessed in a random manner without going through the any other memory location. RAM is a volatile memory. The information written into it is retained init as long as the power supply is on, as soon as the power supply goes off its stored information is lost.The two most important type of RAM are

    - **Static RAM:** SRAM retains its contents as long as power is supplied. It is made up of a flip flop. Static RAM are costlier and consume more power. Si transistor are needed per memory cell in a ststic RAM. It does not need constant refreshment like dynamic RAM chips .Static RAM hold information in a flip flop circuit connsiting of two cross coupeled inverter. In a Ram the memory cell must be associated withread and write facility. Six transistor are neededper memory cell in a static RAM. A static RAM can only store one forth of the information that a dynamic RAM of same complexity hold. Static RAM , with access time 15 to 30 nanoseconds, is much faster than the dynamic RAM.
    - **Dynamic RAM:** A common type of computer memory that uses capacitor and transistor storing electrical charges to represents memory states. These capacitors lose their eectrical charge, and so need to be refreshed every millisecond, during that time they cannot be read by the

processor. DRAM chips are small, cheap, easy to make, and hold approximately four times as much information than static RAM. DRAM requires less no of transistors per memory cell because information is stored Iin capacitors. Only one transistor is needed to form the memory cel of the dynamic RAM.

1. ROM (Read Only Memory)

Read-only memory (ROM) is a class of storage media used in computers and other electronic devices. It is a non volatile memory i.e information is not lost eevn if the power supply goes off. It is used for permanent storge of information. It provides random access property. The stored information in ROM can ony be read at the time of operation. It has random acess property means, data can be eassily retrieved from anywhere without any difficulty or in simple words, data retrieval is faster. ROM is not accessible by user, means information cannot be written into a ROM by user.

Types of ROMs

- **PROMs :** Programmable Read-Only Memory can be written to (programmed) via a special device, a PROM programmer. The writing often takes the form of permanently destroying or creating internal links with the result that a PROM can only be programmed once.
- **EPROMs:** Erasable Programmable Read-Only Memory can be erased by exposure to ultraviolet light then rewritten via an EPROM programmer. Repeated exposure to ultraviolet light will eventually destroy the EPROM but it generally takes many (greater than 1000) exposures before the EPROM becomes unusable. Once programmed, this window is typically covered by a label to prevent accidental erasure.
- **EAROMs:** Electrically Alterable Read-Only Memory can be modified a bit at a time, but writing is intended to be an infrequent operation; most of the time the memory is used as a ROM. EAROM may be used to store critical system setup information in a non-volatile way.
- **EEPROM:** Electrically Erasable Programmable Read-Only Memory allow the entire ROM to be electrically erased then written to without taking them out of the computer .

1.13 Encoding System

The mostly commonly used encoding system are:

- Binary Coded Decimal
- Extended Binary Coded Decimal
- American Standard Code For Information Interchange.

Binary Coded Decimal

In today's technology, you hear a great deal about microprocessors. A microprocessor is an integrated circuit designed for two purposes: data processing and control.

Computers and microprocessors both operate on a series of electrical pulses called words. A word can be represented by a binary number such as 10110011_2. The word length is described by the number of digits or BITS in the series. A series of four digits would be called a 4-bit word and so forth. The most common are 4-, 8-, and 16-bit words. Quite often, these words must use binary-coded decimal inputs.

Binary-coded decimal, or BCD, is a method of using binary digits to represent the decimal digits 0 through 9. A decimal digit is represented by four binary digits, as shown below:

You should note in the table above that the BCD coding is the binary equivalent of the decimal digit.

EBCDIC

Abbreviation of **E**xtended **B**inary-**C**oded **D**ecimal **I**nterchange **C**ode. **EBCDIC** (Extended Binary Coded Decimal Interchange Code) is an 8-bit character encoding. It descended from punched cards and the corresponding six bit binary-coded decimal code

A single EBCDIC byte occupies eight bits, which are divided in two halves or nibbles. The first four bits is called the zone and represent the category of the character, whereas the last four bits is called the digit and identify the specific character.

ASCII

ASCII Stands for American Standard Code for Information Interchange. It is a character encoding based on the English alphabet. ASCII codes represent text in computers, communications equipment, and other devices that work with text.

1.14 How Does Computer store Data

A. Bit

The smallest "unit" of data on a binary computer is a single bit. Since a single bit is capable of representing only two different values (typically zero or one) you may get the impression that there are a very small number of items you can represent with a single bit. Not true! There are an infinite number of items you can represent with a single bit.

With a single bit, you can represent any two distinct items. Examples include zero or one, true or false, on or off, male or female, and right or wrong. However, you are not limited to representing binary data types (that is, those objects which have only two distinct values).

To confuse things even more, different bits can represent different things. For example, one bit might be used to represent the values zero and one, while an adjacent bit might be

used to represent the values true and false. How can you tell by looking at the bits? The answer, of course, is that you can't. But this illustrates the whole idea behind computer data structures: data is what you define it to be.

If you use a bit to represent a boolean (true/false) value then that bit (by your definition) represents true or false. For the bit to have any true meaning, you must be consistent. That is, if you're using a bit to represent true or false at one point in your program, you shouldn't use the true/false value stored in that bit to represent red or blue later.

Since most items you will be trying to model require more than two different values, single bit values aren't the most popular data type. However, since everything else consists of groups of bits, bits will play an important role in your programs. Of course, there are several data types that require two distinct values, so it would seem that bits are important by themselves. however, you will soon see that individual bits are difficult to manipulate, so we'll often use other data types to represent boolean values.

B. The Nibble

A nibble is a collection of bits on a 4-bit boundary. It wouldn't be a particularly interesting data structure except for two items: BCD (binary coded decimal) numbers and hexadecimal (base 16) numbers. It takes four bits to represent a single BCD or hexadecimal digit.

With a nibble, we can represent up to 16 distinct values. In the case of hexadecimal numbers, the values 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F are represented with four bits. BCD uses ten different digits (0, 1, 2, 3, 4, 5, 6, 7, 8, 9) and requires four bits. In fact, any sixteen distinct values can be represented with a nibble, but hexadecimal and BCD digits are the primary items we can represent with a single nibble.

C. The Byte

Without question, the most important data structure used by the 80x86 microprocessor is the byte. This is true since the ASCII code is a 7-bit non-weighted binary code that is used on the byte boundary in most computers. A byte consists of eight bits and is the smallest addressable datum (data item) in the microprocessor.

Main memory and I/O addresses in the PC are all byte addresses. This means that the smallest item that can be individually accessed by an 80x86 program is an 8-bit value. To access anything smaller requires that you read the byte containing the data and mask out the unwanted bits.

The bits in a byte are numbered from bit zero (b0) through seven (b7) as follows:

Bit 0 is the low order bit or least significant bit, bit 7 is the high order bit or most significant bit of the byte. We'll refer to all other bits by their number.

A byte also contains exactly two nibbles. Bits b0 through b3 comprise the low order nibble, and bits b4 through b7 form the high order nibble. Since a byte contains exactly two nibbles, byte values require two hexadecimal digits.

Since a byte contains eight bits, it can represent 2^8, or 256, different values. Generally, we'll use a byte to represent:

1. unsigned numeric values in the range 0 => 255
2. signed numbers in the range -128 => +127
3. ASCII character codes
4. other special data types requiring no more than 256 different values. Many data types have fewer than 256 items so eight bits is usually sufficient.

Since the PC is a byte addressable machine, it turns out to be more efficient to manipulate a whole byte than an individual bit or nibble. For this reason, most programmers use a whole byte to represent data types that require no more than 256 items, even if fewer than eight bits would suffice. For example, we'll often represent the boolean values true and false by 00000001 and 00000000 (respectively).

Probably the most important use for a byte is holding a character code. Characters typed at the keyboard, displayed on the screen, and printed on the printer all have numeric values. To allow it to communicate with the rest of the world, the IBM PC uses a variant of the ASCII character set. There are 128 defined codes in the ASCII character set. IBM uses the remaining 128 possible values for extended character codes including European characters, graphic symbols, Greek letters, and math symbols.

1.15 Number System

Data is usually cmbination of numbers, characters and special caharacters. As computer is an electronic device and it works with electronic pulses, this data or information should be in the form which is machine readable and understandale, for this reason data has to be presented in the form of electronic pulses. The data has to be converted into electronic pulses and each pulse should be identified with a code. For these reason data is to be converted into numeric format first, by making use of ASCII (American Standard Code For Information Interchange), where each and every character, special character and keystrokes have numeric equivalent. There are some number system which are used here are:

1. Decimal Number System:

The **decimal** (**base ten** or occasionally **denary**) numeral system has ten as its base. It is the most widely used numeral system. Decimal notation is the writing of numbers in the base-ten numeral system, which uses various symbols (called digits) for no more than ten distinct values (0, 1, 2, 3, 4, 5, 6, 7, 8 and 9) to represent any numbers, no matter how large. These digits are often used with a decimal separator which indicates the start of a fractional part, and with one of the sign symbols + (positive) or − (negative) in front of the numerals to indicate sign.

The decimal system is a positional numeral system; it has positions for units, tens, hundreds, *etc.* The position of each digit conveys the multiplier (a power of ten) to be used with that digit—each position has a value ten times that of the position to its right. The weighted values for each position is as follows:

2. Binary Number System

The computer represents values using two voltage levels (usually 0V for logic 0 and either +3.3 V or +5V for logic 1). With two levels we can represent exactly two different values. These could be any two different values, but by convention we use the values zero and one. These two values, coincidentally, correspond to the two digits used by the binary number system.

Since there is a correspondence between the logic levels used by the computer and the two digits used in the binary numbering system, it should come as no surprise that computers employ the binary system. The binary number system works like the decimal number system except the Binary Number System:

uses base 2
includes only the digits 0 and 1

The weighted values for each position is determined as follows:

3. Octal Number System

The Octal system is based on the binary system with a 3-bit boundary. The Octal Number System:

uses base 8
includes only the digits 0 through 7 (any other digit would make the number an invalid octal number)

The weighted values for each position is as follows:

4. Hexa Decimal Number System

Just like the octal number system, the hexadecimal (or base-sixteen) number system provides a convenient way to express binary numbers. Table 2-6 shows the weighting for

the hexadecimal number system up to 3 decimal places before and 2 places after the *hexadecimal* point. Based on the trend in previous number systems, the methods used to convert hexadecimal to decimal and vice versa should be intuitive lists the equivalent decimal, binary and hexadecimal representations for the decimal numbers ranging from 0 to 15.

Operations on Binary Numbers

- Addition
- Subtraction
- Multiplication
- Division

1.. Addition

0+0=0

0+1=1

1+0=1

1+1=0 with a carry 1

2. Subtraction

0-0=0

1-0=1

1-1=0

0-1=1 with 1 borrow

3. Multiplication

0*0=0

0*1=0

1*0=0

1*1=1

Complement

- 1’s Complement: One’s complement of a number is arrived at by subtracting each binary digit from 1.

- 2’s Complement: Two’s complement of a given binary number is obtained by adding 1 to the 1’s complement.

- 9’s Complement: 9’s complement of a number is arrived at by subtracting each binary digit from 9.

- 10’s Complement: 10’s complement of a given binary number is obtained by adding 1 to the 9’s complement.

Subtraction By Using 9’s Complement

- Find out the 9’s complement of the number to be subtracted.
- The above arrived figure has to be added to the number from which it has to be subtracted.
- If the addition results in a carry of 1, add it to obtain result.
- If the addition does not result a carry of 1, add 0, then recomplement it and attach a –ve sign

Subtraction By Using 10’s Complement

- Find out the 10’s complement of the number to be subtracted.
- The above arrived figure has to be added to the number from which it has to be subtracted.
- If the addition results in a carry of 1, ignore it to obtain result.
- If the addition does not result a carry of 1, add 0, then recomplement it and attach a –ve sign

Subtraction By Using 1’s Complement

- Find out the 1’s complement of the number to be subtracted.

- The above arrived figure has to be added to the number from which it has to be subtracted.
- If the addition results in a carry of 1, add it to obtain result.
- If the addition does not result a carry of 1, add 0, then recomplement it and attach a –ve sign

Subtraction By Using 2's Complement

- Find out the 2's complement of the number to be subtracted.
- The above arrived figure has to be added to the number from which it has to be subtracted.
- If the addition results in a carry of 1, ignore it to obtain result.
- If the addition does not result a carry of 1, add 0, then recomplement it and attach a –ve sign

Communication Pathways

- The term Bus refers to an electrical pathway through which bits are **transmitted** between the various computer component.
- Or in simple way we can say that it is an electrical path for data to flow from point to point in a circuit.
- A bus is classified according to its function, there are three types of buses

Data Bus
Control Bus
Address Bus

Data Bus

- Data Bus is used to carry out the data throughout the CPU.
- The wider the data bus, the more data it can carry in one time.
- If the data bus is 8bits wide then it carry 8 bits or one character at a time.

Control Bus

- It is the pathway for sending all the timing and control signals to the other units of the system.

Address Bus

- It is the pathway used to locate the storage position in memory where the next instruction is to be executed.

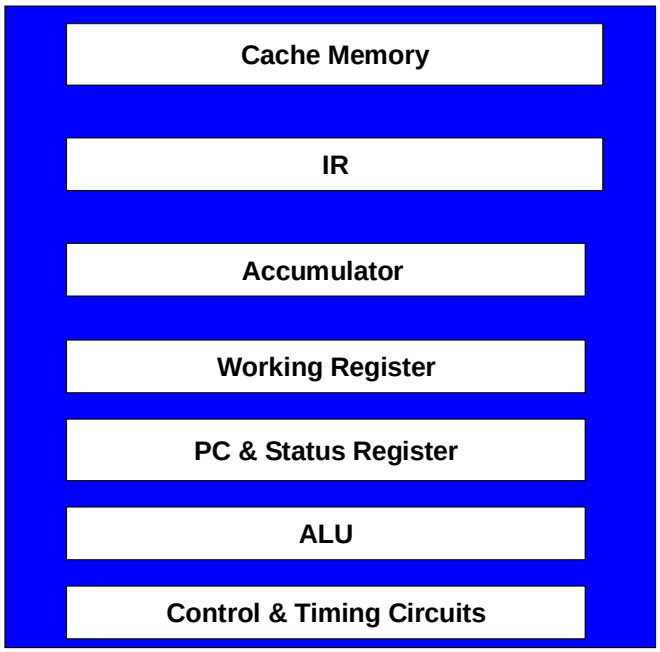
Micropreocessor

- A microprocessor is a digital electronic component with transistor on a single semiconductor integrated circuit.

- One or more microprocessor typically serve as a CPU in computer system.

- Before the invention of microprocessor, the CPUs were typically made from bulky switching devices that has transistors.

- The microprocessor chip contain:



A microprocessor chip can be of

- 8 bit
- 16 bit
- 8/16 bit
- 16/32 bit
- 32/32 bit

I/O Ports

- Input/output devices cannot be interfaced to a microprocessor directly because they are not provided with necessary logic circuitry needed for direct interfacing to the processor buses.
- They are usually interfaced to the processor buses through electronic circuitry called I/O ports.
- An I/O port is supposed to contain device selection logic, bus drivers, data buffers, status register.
- An input device is connected to the processor through an input port. The port is the place for loading and unloading data.
- The input device uploads data into an input port. Then microprocessor reads the data from the input port.
- Similarly, an output device is connected to the processor through an output port. The microprocessor uploads the data into an output port.
- An I/o port may be programmable and non programmable.

- There are two types of ports:
  Parallel Ports
  Serial Ports

Expansion Slots

- An opening in a computer where a circuit board can be inserted to add new capabilities to the computer.
- Nearly all personal computer except portables contain expansion slots for adding more memory, graphics capabilities and support for special devices.
- The board inserted into the expansion slots are called expansion cards, expansion boards etc.
- Expansion slots of PC comes in two sizes half and full sizes
- Half size slots are also called 8 bits slots because they can transfer 8 bit at a time. Full size is 16 bits